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AGRICULTURAL ENGINEERING

The Journal of the American Society of Agricultural Engineers

JANUARY 1929

Research Studies in Large-Scale Farming - - - - - - - - - - *M. L. Wilson*

Some Economic Issues of Large-Scale Farming - - - - - - - - - - *E. G. Nourse*

Ten Years' Experience in Large-Scale Wheat Production - - - *Thos. D. Campbell*

Organization of a Farm for Modern Machinery - - - - - - - - *D. Howard Doane*

Group Management as Applied to Corn Belt Farms - - - - - - - - - *J. M. Dowell*

The Future Trend of Farming in the Middle West - - - - - - *J. Ward Nelson*

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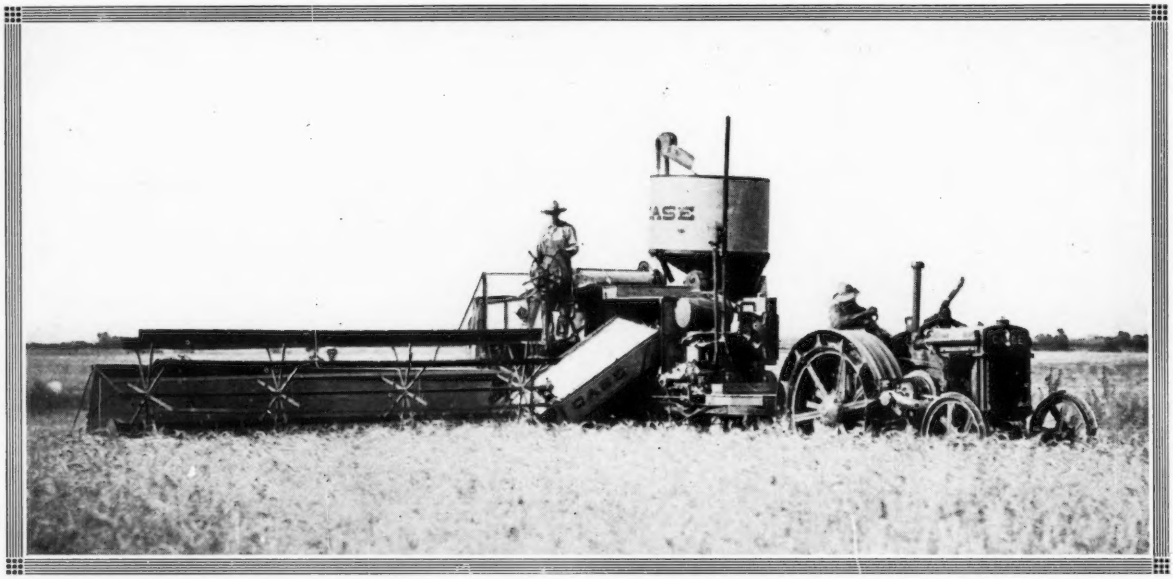

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Published monthly by the American Society of Agricultural Engineers
Publication Office, Bridgman, Michigan. Editorial and Advertising Departments at the Headquarters of the Society, Saint Joseph, Michigan

Subscription price to non-members of the Society, $3.00 a year, 30 cents a copy; to members of the Society, $2.00 a year. Postage to countries to which second-class rates do not apply, $1.00 additional. Entered as second-class matter, October 8, 1925, at the post office at Bridgman, Mich., under the Act of August 24, 1912. Additional entry at St. Joseph, Mich. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921. The title AGRICULTURAL ENGINEERING is registered in the U. S. Patent Office.

WILLIAM BOSS, President — RAYMOND OLNEY, Secretary-Treasurer

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AGRICULTURAL ENGINEERING

Vol. 10 JANUARY, 1929 No. 1

Research Studies in the Economics of Large Scale Farming in Montana[1]

By M. L. Wilson[2]

AS A member of the agricultural economics and farm management group, I desire to express my appreciation of the courtesy extended by our fellow workers in the field of agricultural engineering in inviting us to participate in this meeting which is built around a theme of interest to both economists and engineers. It is a safe prediction that the amicable relationships existing between these two groups of workers will become closer and more reciprocal in the future. While the research in the field of agriculture in the past has largely been centered around the chemical and biological phases of agriculture, at present the two fields of engineering and economics are receiving greatly increased attention.

Large-scale farming is a large-scale subject. Therefore, this paper must of necessity be restricted to one narrow phase dealing with research studies in connection therewith. While there is much that I would like to say outside of the limits of this paper, nevertheless neither time nor coherence to my theme permits it. I do not wish to get into the arguments pro or con regarding large-scale farming, but rather to make some suggestions regarding the necessity for certain types of research in the economic field in relation to large-scale farming and especially in relation to the farm organization and operation phases.

In the farm organization and management field of the general subject of agricultural economics, we are constantly endeavoring to find the types and kind of farm organizations which give the highest ratio of output to input, and in the end the largest financial returns for the factors which enter into agricultural production. Since production is a combination of the land element, the capital or equipment element and the labor and managerial element, which are constantly in flux, the farm organizations which fit best in the economic scheme of things and give the largest returns under one set of conditions at one period of time may at another time be entirely out of adjustment because of changes in prices, changes in technical methods or elements, or changes in the economic organization of society.

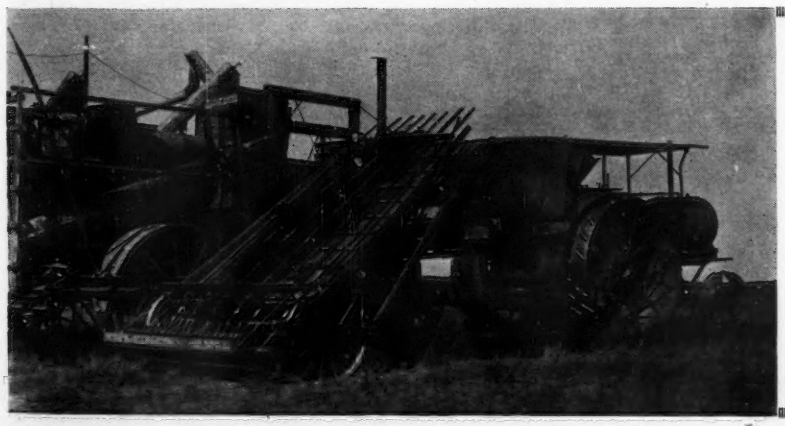
It will be necessary for me to draw such examples as I use from our experiences in the state of Montana, one reason being that specific illustrations are always more forceful than references to things in general; and furthermore, wheat farming in Montana has probably been affected as much or more since 1923 by changes in farm equipment than any other equal area in the United States. Much of this change has been of an economic nature. We estimate that during the period from 1915 to 1917 there were about 35,000 wheat farmers in Montana. Many of these farmers were homesteaders operating half section farms or less. Due to a large number of contributing causes of which the agricultural depression from 1920 to 1924 was the most important, those operating wheat farms have been reduced in number to about 14,000. The best statistics we have, therefore, indicate that at the present time these 14,000 wheat farmers are operating more acres, and doing a better job than was formerly done by the 35,000.

We are conducting a survey at the present time of one hundred successful tractor wheat farms in Montana, and have been surprised at the number of these farms which represent a consolidation into one farming unit of at least three farms or units of land which were formerly separately owned and operated. Most of this progress has taken place since 1924. From 1924 to the present, the number of combines and tractors has approximately doubled each year.

The process of consolidation of individually owned tracts through either purchase or rent, which results in a progressive stepping up of the land base, is a most in-

[1]Paper presented at the meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1928.

[2]Professor and head of the department of agricultural economics, University of Montana.



Large-scale farming, like large-scale manufacturing, calls for large machinery units and mechanical power. This equipment on the famous Campbell farm in Montana is typical

The "family capitalistic farm," as conceived by Mr. Wilson, is the kind of farm which has greatly increased its size and the amount of capital involved in its operation through the introduction and use of modern machinery and other equipment. The farm, however, remains a family-operated unit

teresting phenomenon. It is an evolutionary matter and once started we do not know when and where it will stop. It began with the advent of the modern enclosed-gear, three-plow, one-man, medium-priced tractor.

The typical Montana story begins with the farmer who, we will say, purchased such a tractor in the spring of 1924. He seeded his wheat crop in good season and then started summer fallowing, but he soon realized that he had fallowed all of the remaining tillable land on his own farm, so the natural thing for him to do was to rent an abandoned adjoining tract. He found this new tractor a marked contrast with the old, heavy, clumsy, large-size prehistoric tractor which agricultural historians in Montana have popularly designated as "home wreckers." There were no delays, no exposed drive gears, and before he realized it, he had summer fallowed between 400 and 600 acres with no out-of-pocket expense, aside from fuel.

The next year he seeded from 600 to 800 acres of wheat a lot of it being drilled on good summer fallow, and again he began to summer fallow an additional block of leased, abandoned, or foreclosed land. The crop developed nicely and in July he found himself confronted with a crop too large to cut with the binders he already owned.

Now he had a real problem. "Shall I buy binders, hire a lot of high-priced itinerant labor for shocking and threshing, or shall I buy a combine?" The community wise men said that a combine could not be used in that locality—the grain ripened unevenly, it would shell badly in the winds and rain, and anyway this was a spring wheat section and, as such, was entirely different from the districts where combines were being successfully used. Therefore, it just would not work at all.

But, at any rate, he had the nerve to get the combine and "once over and it was all over." This made him feel so good that, after he had hauled his crop, he said: "If I can do this well with one tractor, perhaps if I purchase another tractor and rent more land I can make twice as much operating with two tractors as with one." He, therefore, went out and rented a second tract of land, even renting perhaps more than he needed in order to keep the other fellow from getting the land ahead of him.

If the combine decision was a difficult problem, it was relatively simple compared with the decision as to the purchase of this second tractor. His mind runs something like this: "Shall I buy another three-plow tractor like the one I now own? As I think about it, I need a little more power, especially on the combine, and there is no reason why one man with a four-plow tractor cannot plow one-fourth more than one man with a three-plow tractor. But if I get a four-plow tractor can I give it an efficient load of duckfoots, drills and other implements? Perhaps I might sell my present three-plow tractor and buy a new six-plow tractor, but if I do that I will have to get new plows and much of the machinery I now have will be obsolete."

At any rate some of these farmers purchased three-plow tractors, many bought four-plow tractors, and still others wiped the slate clean and purchased six-plow outfits. As a result of this type of evolution we have in Montana today hundreds and hundreds of farms that we choose to call "capitalistic family farms," on each of which one family operator without a great amount of hired labor is handling between one and two thousand acreas of tillable land. The vacant, adjoining available lands of good character are now about all leased or under purchase contract. This represents one stage in the evolution of Montana wheat farming.

A vital question is raised, namely is this evolution now over since the available lands for consolidation are exhausted? Have we reached a new dead level in farm organization, or are we to have a new kind of competition between these capitalistic family farmers whereby men with outstanding managerial ability are being trained to become real large-scale capitalistic managers in the future? And are the more successful of the family capitalistic farmers to evolve into what Thos. D. Campbell calls industrial or factory wheat farmers?

Here, we believe, is an opportunity for research to get ahead of the procession instead of trailing behind and studying and explaining what has already happened. If agricultural engineers and economic investigators can solve some of the problems involved in this evolutionary process, may not it save a great deal of costly and painful cut-and-try experimentation on the part of farmers? If this is true and if economic investigations show unmistakable evidence that under existing and anticipated future conditions, with power units, and equipment design, trending in certain directions, then may we not hasten the evolutionary process, thereby saving tremendous waste in human effort and in cash outlay for the purchase of equipment of sizes and kinds which are destined to become obsolete as the size and organization of farms change? There is no question but that everywhere this problem exists, and research people, especially engineers and economists, will lose the opportunity of a lifetime if they fail to take advantage of it.

At this point we find it necessary to give some definition to the concept of a "family capitalistic farm" and a "large-scale farm." By the family capitalistic farm we mean the kind of farm which I have just described which has greatly increased its size and the amount of capital involved in its operation through the introduction and use of modern machinery. The farm, however, remains a family operated unit, but when we consider the social and psychological factors involved in the relationship of the farm family to the farm and the community, we find

that they are entirely different from what we have considered to be the typical characteristics of family farms in the past. By the large scale capitalistic factory or industrial farm we assume that the units of machinery and operation are brought together under one central managerial function, and that there has been a specialization in the labor functions of the farm, such as has taken place in the factory. It is indeed quite difficult to draw hard and fast lines. When I think of a three-plow tractor capitalistic family farm in Montana operating from one to two sections of wheat land, I do not consider this large-scale operation, but when several of these units are put together under one managerial head it becomes a large-scale or fully capitalistic organization.

In addition to capitalistic family farms we also have in Montana several capitalistic factory or industrialized farms, notably the Campbell farm, the largest industrialized wheat farm in Montana and from many angles one of the most interesting tractor-farming enterprises in the whole country.

Underlying our whole agricultural system for the past century, aside from the plantation system in the South, has been the assumption that the family farm was most desirable both for economic and social reasons. This idea has been fostered in the way of national agricultural policy from the days of Thomas Jefferson to the present. The homestead law was a national effort directed towards the propagation of the family farm. Our agricultural educational and research system which functions through the colleges, experiment stations, and extension services has never questioned the validity of this underlying assumption. Many of those interested in the economic status of the farmers have readily granted that the financial rewards in farming were not entirely satisfactory but argue that in addition the farmer received what is termed "a psychic income;" in other words, a certain compensation aside from monetary returns. Therefore, farming was not exactly a business comparable with other lines of industry, but was a mode of living in which the returns were partially monetary and partially in other satisfactions not

We find ourselves now faced with the much discussed farm problem which is no doubt an outgrowth of a situation in which the farmer finds himself. The bare facts are that in many cases the "mode of life" family farmers do not receive sufficient cash returns to pay their out-of-pocket farming expenses, give their families the standard of living which they desire and at the same time allow sufficient capital accumulation for financial progress. In other words, they would like to trade a little of this "psychic income" for cash.

The present farming problem as such is not to be discussed in this paper. However, the situation recited above raised the question as to whether or not there is some other form of organization of the agricultural industry which may be more in keeping with our national and industrial life and whether or not reorganized farms based on large-scale industrialized or capitalistic farming is one type of solution. This solution has been least suggested in the manifold discussions of the agricultural problem, but it has sufficient basis for the most careful investigation by our research agencies.

This paper is limited to two fundamental aspects of large-scale farming: First, is large-scale industrial or factory capitalistic farming from an economic standpoint more efficient than family or mode-of-life farming and, if so, what are the reasons? How can new large-scale farm organizations be organized out of existing farms? This point of view involves new goals and objectives in agriculture. If these goals are economically and socially desirable, then the practical side of the question is how to reach this distant goal. Second, the other question has to do with adjusting and adapting present farm organizations of family capitalistic farms such as they are so as to make the most economical and efficient use of new equipment in the way of power units, tractor equipment, etc. This is the evolutionary point of view and assumes that we start with farms as they are making successive reorganization changes, thereby adapting them more closely with changes brought about by agricultural engineering in the field of design and operation of farm equipment.

METHODS OF RESEARCH

When we talk of large-scale farming we must remember that there are all kinds and types of farms and likewise many different measures of size and scale of business. Research will not go far until it breaks up into studies dealing with the relationship of large-scale operations in particular types and kinds of farming. In general, three kinds of economic investigation are adapted to this field.

First, farm organization and operation surveys in which basic material is secured by trained investigators through the survey method. Such studies are particularly valuable in getting a cross-section of a given situation, to find out what is happening and to uncover a mass of detailed prob-

The "great open spaces" of the wheat country lend themselves more readily than most other sections for the development of the large-scale industrialized or capitalistic type of farming

lems for further investigation, both by the engineer and economist.

Second, case studies, oftentimes supplemented by daily detailed records and accounts. The case method of the study of business units was introduced very largely by the schools of business and commercial administration of the larger universities. This method depends upon selecting specific cases for particular reasons and studying and analyzing these with almost microscopic minuteness. The investigator delves into the historical background of the particular case, its evolution, its personnel, its economic resources, the situation with reference to land, availability of capital, managerial qualifications, etc. In this method the investigator tries as closely as possible to affiliate himself with the executive and the manager so as to be on the "inside," so to speak, of all decisions which are made. We have found by experience that when outstanding successful cases are selected for this type of study, they are apt to prove to be a dependable source of standards for daily accomplishments and practices. Sometimes as much or more can be learned through the study of organizations which are not prospering and as a result supply a plan for reorganization and readjustment. Statistical methods such as are used with the survey are not adapted to case studies; instead much depends upon the accuracy and judgment of the investigator.

In Montana we have had to depend largely upon the case method, due, first, to the limited number of large-scale farmers, and, second, to the fact that so many of our large farmers are in a state of flux and rapid evolution such that the managers themselves are not satisfied in their own mind that they have by any means reached a degree of stability and permanence in their operating plans.

Third, the experimental method. This involves working out with agricultural engineers and agricultural technicians deductively what would appear to be the most profitable and efficient farm organization possible under a given set of conditions, designing a farm so to speak the same as an engineer designs a machine to meet certain specifications and to perform certain work. After the design has been made, the farm is then set up as an operating unit as a test of the validity of the hypothetical reasoning lying back of it. This method is the least in use, requires the most capital, and is probably the most productive in results of any of the three discussed.

The Fairway Farms Corporation of Montana, financed by a loan from Mr. John Rockefeller, Jr., and operated partially in cooperation with the department of agricultural economics and farm management of the Montana Agricultural Experiment Station, falls partially, but not wholly in this category. This project was designed first as an experiment with the theory of landlord-tenant relationships whereby the landlord retains the financial and managerial supervision of the farm operated by the tenant, who evolves from the position of tenant to tenant-purchaser and, it is to be hoped, ultimate owner. These farms, therefore, with exceptions which will be noted shortly, become family farms, but are directed more or less by corporation methods. The ultimate aim is to direct and train and assist the tenant to become an owner; at the same time this is to be done by a business corporation which it is hoped will be able to pay the current rate of interest on the capital invested, plus sufficient net profits such as to induce enterprisers in the economic field to engage in such operations, plus the cost of managerial and financial supervision. The corporation at present is operating nine farms. At the inception of the present farm organization, plans were worked out deductively for each farm, both as to equipment and operation. One of these farms consists of 3,000 acres, known as the Lone Warrior Farm, located at Brockton, Montana. It is at present being operated as a tractor experimental unit, in connection with problems bearing upon large-scale wheat farming in Montana. Four other farms range in tilled areas from 1,000 to 2,000 acres and fall in the class of capitalistic family farms. The remaining farms are typical of the diversified small farms such as we have in the Northwest. We shall have more to say regarding the experimental work in connection with these farms later.

In discussing the first of these questions, namely, is large-scale or capitalistic farming from an economic standpoint more efficient than family or mode-of-living farming? If so, how and why? It is certainly logical to assume that the major premise in any form of reasoning about this problem would embrace the assumption that the large-scale or capitalistic farm must be sufficiently efficient and economic that returns and profits will allow the large-scale or corporation farmer to outbid the family farmer for his land and under conditions of economic competition take it away from him. It seems to me that this is the crux of the issue. The question cannot be very satisfactorily answered because so far as I know we do not have many such studies or many facts from which to draw conclusions. While it is true there is much talk at the present time about capitalistic or large-scale farming, nevertheless, the hard cold analytical facts upon which to base conclusions are decidedly lacking. The division of farm management and costs in the Bureau of Agricultural Economics of the U. S. Department of Agriculture has initiated a project dealing with capitalistic farming in the United States, and perhaps some of the experiment stations have similar projects under way, but so far as I know there is but little available in the way of published results.

It is indeed difficult to find a simple term to express varying efficiencies between these tractor farms. We use the term acres farmed per tractor laborer, not with any claim that it covers the whole of a very complicated set of factors, but rather for the sake of simplicity and convenience.

Now if we are to assume that the hours of man labor per given unit of power is a good index of the efficiency of production where the land and machinery remain comparable, then it is also logical to assume that as the labor requirement per acre goes down and the results attributable to machinery production per acre go up, such conditions are favorable towards evolving larger units. Furthermore most of the epoch-making changes in agricultural machines in the last decade have had to do with wheat raising and because of these changes in the mechanism the man labor requirements under conditions prevailing in Montana have been reduced from 10 or 14 hours per acre to an average figure fluctuating between two and three man-hours per acre. We, therefore, should find indications of a shifting from the family farm to the large-scale farm in the Montana wheat country. Due to my limited acquaintance with the other sections of the country it is necessary for me to draw certain illustrations from Montana. The situation is particularly relevant there because the major part of the wheat is raised by what we choose to term three and four-plow tractor farmers, that is to say, farmers who during the last four years have purchased types of tractors which pull three and four plows on loam soils.

Now, outside of the special conditions that prevail on the Indian reservations, in order that large-scale wheat farming may grow and thrive, it must compete for the land with these three or four-plow tractor farmers and must be sufficiently more efficient and economical that it can, over a period of years, outbid and take the land away from the three and four-plow farmers. Let us turn to the case method and set forth some typical cases of standards of accomplishment and efficiencies prevailing on some of the larger tractor farms with the idea of comparing these with the three and four-plow tractor farmers.

The Campbell Farming Corporation. The outstanding large-scale wheat farm of Montana and, for that matter, of the world is the Campbell Farming Corporation farm at

The principal incentive in the development of large-scale farming is to reduce production costs. Placing large, efficient equipment units under the control of one man is one of the most important means to this end. As large-scale farming develops, there will be an increasing demand for larger machine and implement units, and especially units that require only one man to handle them

Hardin. Since Mr. Campbell is on the program I feel that anything that I would say about his farm would be second-hand and of a very superficial nature. It is a great experiment and laboratory in factory farming and has contributed the greatest portion of our knowledge regarding large-scale tractor farm organization, labor management, field service to batteries of machinery, central machine shop and field repair service and unit operation and the relation of these units to the central organization, and in fact all of the details that go into the organization and operation of such a great enterprise. Mr. Campbell's operations, of course, are entirely confined to an Indian reservation where the land situation has been such that he could lease such units and tracts of land as he desired, thereby getting a compact body of land for each operating unit. Mr. Campbell is a great organizer, and I wish to pay very high respects to his wonderful organizing ability.

The Montana Agricultural College and Experiment Station have no detailed records from the Campbell farm. The reason for this is we have never asked Mr. Campbell for the privilege of getting such records. Every time we have visited the Campbell farm, Mr. Campbell or his office force were working under such great pressure that we did not feel like asking them to drop pressing current work and operations in order that we might have access to their records dealing with man labor and operation expenses. Mr. Campbell has been exceedingly courteous to everyone connected with the college and the fact that we do not have such records is our fault and not Mr. Campbell's. If funds were available, we should like to ask Mr. Campbell for the privilege of placing a field record and account man on his largest unit No. 4 during the operating season, and work out some kind of joint co-operative agreement with Mr. Campbell whereby this man could secure the type of data that would give us information relative to their labor and operation output. With such data we believe we would have some basis for comparing this type of organization with the smaller farms. In passing, however, I should emphasize that while there are many interesting things about the Campbell operations there are two things which very greatly impressed me. The first is the servicing of their tractors as a result of which the Altman-Taylor 30-60-hp. machines which were purchased in 1918 are in full operation today. Any engineer who is interested in this line of work will find the study of Mr. Campbell's shop system and system of overhauling tractors very unique. Second, the unit organization and method of operations of these units. We have every reason for assuming that a detailed study of Mr. Campbell's operations would show very high efficiency.

The Schnitzler Farm. The Schnitzler farm, located at Homestead, is the second largest wheat farm in Montana. It consists of 7,000 acres of land, most of which are now owned. The operating plan gives about 4,000 acres of wheat each year, 300 acres of miscellaneous feed crops, pasture, roads, etc., and 2,700 acres of fallow. The farm is operated from one central headquarters, which is located about three miles from the shipping station. Like the Campbell farm it is located on Indian lands, on the Ft. Peck Indian Reservation. The farm started with a single Altman-Taylor 30-60-hp. tractor and leased land in 1914. It has grown primarily from the first 800 acres in more or less of a self-contained manner. I doubt if Mr. Schnitzler has put in very much, if any, additional capital and its growth from year to year has been made from the profits of the previous years. Mr. Schnitzler is an A No. 1 high-grade manager. He gives the farm a great deal of his personal attention and in addition has an excellent foreman who is both a good mechanic and a good foreman. The only overhead men connected with the farm who do not operate tractors are the foreman and the shop man.

We have been studying the Schnitzler farm for a number of years and are thoroughly convinced that he secures consistently higher acre yields of wheat than the neighbors in his vicinity. This is due to both timeliness as far as operations are concerned and to good careful farming. Up until 1927 the farm was operated by four and sometimes five 30-60 Altman-Taylors; in connection with these from 40 to 50 horses were maintained. The horses were used primarily for drilling and for bundle wagons while threshing. During the past ten years there has been a certain amount of sod breaking each year, consequently it is only recently that the farm has changed over principally to a summer fallow basis.

Beginning of 1926, Mr. Schnitzler began shifting to three-plow tractors, his argument being that when speed was considered, quality of work, cost of repairs, etc., a three-plow tractor was far more economical than the 30-60's. He also argued that with 30-60's it required one engineer and one plowman per power unit. The outfit traveled two miles per hour, whereas with the three-plow tractors no plowman was needed and the two three-plow tractors at a more rapid speed could do considerably more work than the two men on the 30-60 with 8 plows.

For the past two years, the 7,000 acres have been operated with seven three-plow tractors, plus some horse work and a little assistance now and then in case of emergency from the old Altman-Taylors, which are now on the retired list. In 1927 Mr. Schnitzler purchased a combine and began experimental work with the combine method. In 1928 the farm produced about 135,000 bushels of wheat. Between half and two-thirds of this was harvested with a

combine thresher and the remainder cut with binders and threshed. On the basis of this year's experience, however, Mr. Schnitzler regards his binder and threshing equipment as obsolete. This past year another shift has been made and two crawler type tractors were purchased. It is the opinion of Mr. Griggs, the foreman, that the work on the 7,000 acres can be most expeditiously and cheaply done with the use of four six-plow tractors of the "30" track type, supplemented if necessary, by two three-plow tractors or perhaps one three plow tractor and one general purpose tractor. These will be held in reserve to use only in case of bad weather or delays. It is impossible because of the horse work and the shock threshing to unscramble the labor situation so as to get a reasonably accurate statement as to the number of acres farmed per year per regular laborer. By making certain adjustments, however, in order to make a comparable estimate of field labor, harvest not included, we have worked out the following:

Period 1—Four 30-60 Altman-Taylors, 120 drawbar horsepower, approximately 10 men, or 700 acres per man.

Period 2—Seven three-plow tractors, 105 drawbar horsepower, seven men, 1,000 acres per man.

Period 3—Four 30-hp. track-type tractors, 100 drawbar horsepower.

Now when adjustments are made for supplemental tractor work, it is estimated that approximately 1,600 acres per man will be farmed per tractor laborer, of which approximately 540 acres will represent summer fallow, both plowed and plowless, 540 acres of wheat drilled on summer fallow and 540 acres stubble land tandem disked and drilled, or, as it is called, the second year summer fallow.

The above calculations have largely eliminated harvesting operations. The machine investment on the Schnitzler farm is considerably under $10 per acre. Our studies on this farm are tending to show, because of this superior management, they are getting a larger output per man than are the neighboring tractor farmers.

The O'Day Farm. This farm consists of 3,000 acres of level tillable land owned and operated by R. S. O'Day, of Fife, Montana. Mr. O'Day is a graduate of the college of agriculture at the University of Minnesota and has operated this farm for about ten years. He has evolved through the various types of tractors until 1922 when he went on a straight summer fallow basis, and purchased his first track-type tractor. In 1924 he purchased a 24-foot combine. Mr. O'Day is a man who places great emphasis on the timeliness at which work is done and strives for the highest possible yields. I do not have the exact figures at hand, but believe that since 1924 Mr. O'Day's winter wheat which has been raised on the very best summer fallow will average well over 40 bushels per acre. In 1926 he disposed of all of his old equipment and purchased two new 60-hp. track-type tractors. He operates the farm with two regular engine operators and one flunky. The plowing is done with disk plows, and the summer fallow cultivated with duckfoot cultivators. In 1926 the farm yielded 63,000 bushels, in 1927 about 75,000 bushels, in 1928 over 60,000 bushels. Mr. O'Day argues, and we believe correctly, that the reason farm yields do not closely approximate experiment station yields is due largely to the lack of timeliness in the farm operation. In other words, experiment station plots can be plowed, drilled, harvested, etc., at the optimum time and that in the operation of large-scale farms there should be sufficient power so that the operations can be carried out very quickly and approximate the optimum time in order to secure the highest possible yields. His system is a straight summer fallow system, plowed with disk plow, and with his two tractors he has been able to keep ahead of the work at practically all seasons of the year. He says that he desires to have on his farm sufficient power that he can cover all his summer fallow in four days.

Eliminating the harvesting period, the O'Day farm is now being operated on the basis of about 1500 acres per tractor field laborer. Mr. O'Day further claims that manufacturers are not giving the large-scale farmers a fair

If the combine harvester does not entirely eliminate this, the shocker and shock loader will, under large-scale farming conditions, do away with the human effort which this type of harvesting represents

chance, that all machinery is far too light in its construction to be used with the large size power units, which he believes to be essential to large-scale operations. Consequently, he states that whenever he buys drills, duckfoots, and machinery of that type the first thing he has to do is to go to an iron store and purchase some honest-to-goodness heavy angle iron and replace as much of what he terms the toy tin frame as possible. You can readily understand that as far as an implement is concerned, there is a lot of difference between its being hitched behind a three-plow tractor and a 60-hp. track-type tractor. Consequently Mr. O'Day maintains that the highest degree of efficiency for large power units is not going to be reached until manufacturers build heavy machinery adapted to such power units. Mr. O'Day also has difficulty under certain conditions in giving their tractors their optimum loads. In our experimental work we found that six-plow tractors of the track type could pull 33 feet of duckfoot cultivators on summer fallow with comparative ease. Now unless conditions are favorable, a load of 66 feet of the present type of duckfoot cultivators, I am afraid, would not prove very practical. We are inclined to think that the O'Day farm reaches about the maximum of labor efficiency and that under prevailing conditions farms of the O'Day type with the O'Day managerial ability can succeed and grow in competition with three-plow tractor farms.

Three Forks Land Company. The Three Forks Land Company, located at Three Forks, Montana, presents another case in which is operated 4800 acres of land, 2800 acres in crop and 2000 acres in summer fallow, by six three-plow tractors. All of the work on this farm is done with six three-plow tractors, or an average of 800 acres per man. Most of these tractors are now in the third year. They have been overhauled and serviced and are still giving good operation. It is doubtful if the inventory value of the operating equipment on this farm will run over $6 per acre.

Case Farm No. 14. The operators of this farm have not given us permission to disclose their identity. It is one of the most interesting and important farms among our case studies. It is operated by three partners. One is an expert mechanic; the second member is a man of good judgment and experience in farming matters. He is the farmer and foreman of the operations. The third member is a graduate of the school of commerce and ad-

ministration of one of the western universities. He is a man of natural aptitude towards business and is well trained in matters of accounting, business management, etc. He is the business manager of the farm. This farm started operations in 1925 when 1190 acres were operated by these men on an average of 200 acres per man. In 1926 the farm stepped up to 1840 acres, with an average of 6½ men during the operating season up to combine time, or 280 acres per man. In 1927 again the farm increased its acreage to 2800 acres, with 8½ men during operating season, or 340 acres per man. In 1928, 1200 acres were added, or 4000 acres were farmed by seven men with an average operating acreage of 570 acres per man.

These acreages appear low, but much of the plowing has been breaking of native sod. If the sod breaking were expressed in terms of stubble plowing, then the acreage would be about doubled. In 1928 this farm raised 90,000 bushels of wheat from approximately 3,000 acres. The power consists of four four-plow tractors. They have approximately one-third of their acreage in summer fallow, two-thirds in crop which was harvested with three 20-foot combines. The investment in equipment runs about $8 per acre.

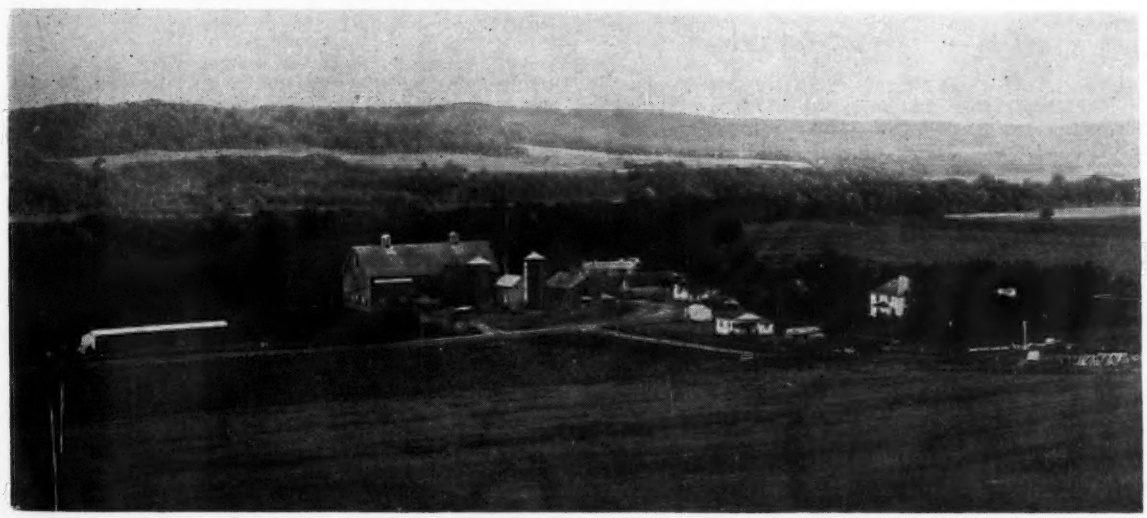
Time does not permit any more summaries of case farms which we have been studying, neither does it permit us to go into any more detail with regard to three and four-plow tractors which are typical of what we choose to term the three-plow tractor or capitalistic family farm. We have records on a number of these farms which all point in the same direction, namely, that with the three-crop system, i.e., summer fallow, wheat seeded on summer fallow, and a second crop of wheat seeded in the stubble with three and four-plow tractors, when operated by the individual owner at very maximum capacity, are capable of turning out between 800 and 1000 acres per operator. There is tremendous variability in the acres farmed per tractor on these farms. We are inclined to think, however, that farmers who are not getting more than 400 acres per three-plow tractor under Montana conditions of farming are not going to last long. On the other hand, we have many intelligent, ambitious, hustling operators who are careful in the upkeep of their equipment, who sometimes run night shifts and who are economical on hired labor, who are ranging between 800 and 1000 acres and still doing the work well.

By way of summary we may say our studies thus far have not always indicated that there is as wide a difference between the output per man on the capitalistic large-scale farm and the three and four-plow family farms as we had at one time thought would be the case. In considering this matter, however, it must be remembered that the larger unit farms have constantly complained that machinery and equipment was not built which was adaptable to the large power units. If the original assumption is correct and if the data which I have presented, which as far as Montana is concerned is by no means final or conclusive, is true, then if capitalistic or large-scale farming is to grow at the expense of three and four-plow tractor farms there must be some other economic reason for this growth rather than the output per individual worker.

We are inclined to believe, however, that in making these comparisons the story is not entirely told, and there remain three very important factors which have not been discussed. First, financial care and judgment as related to the management of the farm; second, buying and selling and business details; and, third, the quality of farming and rapidity of adjustment to better methods of production.

Our case studies indicate unquestionably that the large-scale farmers are exhibiting far greater care in financial matters. They have been accumulating and building up financial reserves in the form of safe and liquid investments which are available at any time in case of crop failures. With the 1928 crop practically all of the cases which we are studying of large-scale wheat farming in Montana have now built up cash reserves which would take them through at least two years of partial or complete crop failure and the operators have gone to California besides.

On the other hand, the family three-plow and four-plow tractor farmers have not been able to build up reserves comparable to the large farms. Their scale of family living has greatly increased, it is true, and a great many have been spending the winters in a warmer climate, but, on the whole, they are not accumulating any such reserves as is the case with the large farmers. Now it is reasonable to assume that history will repeat itself and that we are apt to have two complete or partial failures in succession. If such is the case, many of the poorer managers among the three and four-plow tractor farmers will find themselves very greatly embarrassed and unless some financial agency is willing to carry their debts and finance them for a third year, these farmers may find themselves upon the brink of bankruptcy, in which case I should expect large numbers of them to be swallowed up by large farmers. As a matter of fact, I anticipate that this is going to be evolution whereby large farms are going to come into existence in Montana.



The development of large-scale farming will bring with it problems in the design, construction, location and arrangement of buildings that will not be less difficult or important than those involving the selection and application of machinery

Second, marketing and general business skill. We also have unqestionable evidence that the large-scale farmers have exhibited far greater skill in marketing of their wheat, doing such things as preharvest protein tests, segregation and sale of wheat of different protein content. Many of the large farmers are either shipping their wheat direct or are sufficiently posted on marketing conditions that they know exactly what the prices are at the terminals and what are the costs of marketing so that in case the local marketing machinery is not reflecting the true value of their wheat they are in a position to make direct shipment themselves. Time does not permit details in this connection, but there is considerable evidence that this is the case.

Third, cropping methods and management on the whole. Perhaps there is not much difference between the quality of work done by the good large-scale farmers and the good three and four-plow tractor farmers. However, we are inclined to think that in general these large-scale farmers who are sold on the theory of 50 per cent reserve power and timeliness in operation are doing the best job of wheat farming in Montana and are securing the highest yields and greatest net profits thereby. The large scale of operations is such on the large farms that they can discard obsolete items of machinery without materially affecting the farm as a whole, which of course is not true of the smaller farms.

In summary we should say that this question of the competition of the large-scale farms with family tractor wheat farms in Montana is complicated and by no means a simple problem. The number of possible cases is limited. There are probably not more than twenty Montana wheat farms that fall within that category. Again the capitalistic family farmer is increasing his efficiency as fast as he knows how, thus not making it any easier for the factory farm to get a foothold.

If we had the whole settlement of Montana to do over again and were faced with the question of recommendations as to whether we should have large-scale or small-scale tractor wheat farms, we think we should be inclined to go as far with large-scale tractor farms as there was available managerial ability to operate them. The capitalistic or large-scale farm can win its own way because of superiority and greater efficiency in competition with the family capitalistic farms, but we are convinced that large-scale farms require manager operators of exceptional managerial ability, experience, and training. Such men are rare. No doubt many are now being schooled and trained with the experience in the operation of three, four and six-plow tractors. Very likely in Montana at the present time we have about as many large-scale wheat farms as we have large-scale managers of the ability necessary to make them successes.

The factory wheat farm is especially adapted to a farming situation where machinery is substituted for labor, where it takes considerable amount of capital and where a large farm is necessary to insure most efficient operation of costly machinery. I have not intended to infer that what has been said with reference to large-scale wheat farming in Montana can be generalized and may be applied in principle to all farming everywhere. I wish to guard against this and to emphasize that each type of farming is a special problem within itself. Before general statements at least of a scientific nature are made, we need studies of the economics of large and small-scale farming in specific types of farming and specific farming areas.

If we are to have capitalistic farms, or for that matter farms which are going to employ well-paid, highly skilled managers, then we have another new problem in education. May it not be logical to imagine that in the future the fields of large-scale farming will pass through an apprenticeship much as now takes place with the electrical and mechanical engineers? Possibly we might develop something of the University of Cincinnati system, of part-time college attendance and part-time work in the industry. There are right now a number of positions that would be open for the college trained man, providing he had the hard, vigorous training which comes from actual field operation. Unfortunately there is a great scarcity of men who have both the things which the college can give and the judgment and insight which come only through hard-boiled field operation. If such type of education were to come into existence, no doubt both professors of agricultural engineering and mechanical economics, especially in the farm management field would be extremely anxious for sabbatical leave of such a nature that would allow them to take over the management and operation of farms in the field in which they were specializing.

There are many, many things about the capitalistic wheat farm which I should like to discuss, such as the comparison between repair and service work done in the central machine shop with the work of an ordinary farmer in the average farm shop. Also the tendency on the part of some farmers to get a kind of a "esprit de corps" spirit instilled into the crew which is not so apt to be the case when one or two men are working alone. Again there is the matter of the special training of men on special machines and the problem of year round employment for the better men. Time does not permit of any of these discussions, but I am sure that there has arisen in the minds of most of you two questions which need, at least, a word in passing.

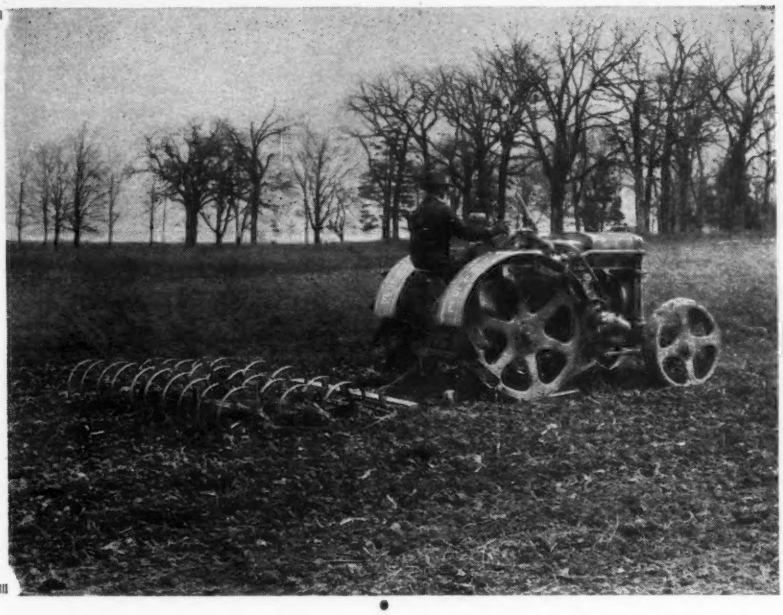
First, what about the social side in the community? Is this going to bring about a degraded class of farm laborers to replace independent farm families? And what about seasonal labor employment?

When we discuss the community phase we should do all we can to make certain that we are facing the future and not the past. Some of our Montana people feel that large-scale wheat farming will entirely destroy the rural community, and that the economic gains will entirely be offset by tremendous social losses. These people have not as yet developed any specific program, but if they were to be perfectly logical and scientific I am inclined to think that their program would have to be made up of three elements: First, a vigorous, red-blooded, ardent campaign against the automobile and the substitution of the horse and buggy therefor; second, propaganda against the truck, proposing the team and wagon as the substitute, and possibly ungraded dirt roads which can be maintained with less tax outlay; and third, a campaign against the graded school, especially against country children going to high school.

Now the facts are, regardless of whether we like it or not, that the auto, the truck, graded roads and the desire to give children graded school, and especially high school facilities, are the things which are utterly destroying the old Montana farm community, not the machine tractor. These are bringing into existence entirely new and different community organization and relationship. If rural sociologists prove to be constructive human engineers and not social historians, perhaps they will design something out of this situation that will give this wheat farm family higher social and spiritual value and the opportunity for realizing higher life values than was true with the old restricted, isolated community.

As to the laborer, perhaps it would be best to return to the facts from the case farms. On the Campbell farm nearly all the laborers are single men, who are paid wages which range above the wage of the ordinary western ranch hand, depending, of course, upon the responsibility and the amount of work done. If the men work all summer they receive additional bonuses. If they work long hours they receive extra pay. They are well fed, lodged in clean bunk houses, and are considered better cared for than most men who live camp lives. Most of them are young men who like mechanical things. They go somewhere—I do not know where—in the winter, and like the migratory birds return in the spring. I presume that most of skilled men are getting to be repeaters; that is, they come back every spring. Mr. Campbell also urges the most capable of the youngsters who are working for him to

The economic problem in adapting present farm organization to make the best use of power and equipment, involves organizing farms around available power and equipment units to get maximum efficiency and largest net returns



attend the winter short-courses at the state college of agriculture, with the expectation that they can there receive a kind of training to fit with their operation experience which will enable them to rise in this field of industry.

The men on the Schnitzler farm are well fed and housed. They come mostly from neighborhood farms and are mostly boys that like tractors and machinery. The farm pays a little higher than average wages and expects to get better than average men. A part of the crew are retained the year round. The farm has a large, heated machine shop and during the winter every single piece of machinery is taken into this shop and thoroughly and completely overhauled. I wish to emphasize these words, thoroughly and completely. I once asked Mr. Schnitzler about the time lost from breakage and stoppage in a certain operation which was causing a lot of trouble on tractor farms in Montana. He replied: "We have not had a single stop on spring work, but you must remember that we work all winter in order to prevent it." The men on this farm work the preventive treatment to the limit. Every machine is inspected by Mr. Griggs himself, and any part that he thinks is apt to give out during the next season's run, is completely replaced or strengthened. In order to give full winter employment to the foremen and some of the men, they are operating in the village a machine shop where they are overhauling and rebuilding tractors for neighboring farms. Mr. Schnitzler lives in the village, ten miles away from the farm. He has purchased an airplane and keeps a pilot so that he can take a bird's eye view whenever he feels like it.

The O'Day farm is principally a family crew. Mr. O'Day lives in the city, ten miles from the farm. The Three Forks Land Company employs mostly married men, who live in town, and drive to their work in cars. None of the work is more than ten miles distant. About half the men are employed on a year round basis.

In our survey of the one hundred successful tractor farmers we have been surprised at the number who say they plan on living in town in the winter and give as their reason the opportunity of giving the children better schools.

We will now briefly discuss the second question raised in this paper, namely, the problems which have to do with adjusting and adapting present farm organization such as they are to make the best use of the present farm power and equipment. This discussion must be made because the theme of this paper is the large-scale farm, and I do not consider the capitalistic family farm a large-scale farm. This is the more practical question of the two and probably represents ninety-five per cent of the actual wheat farming problem in Montana at the present time. While we only have a few large-scale capitalistic farms, we have about 14,000 wheat farms which belong to the three and four-plow category. The economic problem resolves itself, therefore, into how farmers can organize their farms around available power units and items of equipment such as to get maximum efficiency and largest net returns.

The work carried on this past year at the Lone Warrior Farm at Brockton has had principally to do with this type of problem. This farm of 3,000 acres is divided up into a number of fields and the work of different power units of different machinery has been operated in such a way that we can take certain fields and put them together in a certain manner and get different kinds of farm organizations for three-plow tractor farms. Likewise we can take other fields and put them together in another combination and get different types of four-plow tractor organizations and certain other fields and combinations we can get six-plow tractor types of organization. The six-plow tractor unit can be operated by one six-plow tractor or two three-plow tractor units.

The business for the year is not closed but we estimate the gross returns at $21,000.

The work on this farm during the past year has been cooperative between the department of agricultural engineering and the department of agricultural economics and farm management of the University of Montana. The agricultural engineering department has been studying the drawbar pull of various implements and combinations of implements in relation to the work done under varying conditions, fuel consumed, slippage under field conditions, etc. They have designed and tried out several new hitches and combinations of machines.

On the other hand, the agricultural economics department has been keeping close labor and operation records and has been concerned primarily with the problem of labor distribution with combinations of crops and enterprises, etc.

The equipment for this experimental work has been loaned by the various manufacturers for which we are indeed very appreciative. This experimental work would not have been possible except for these loans. We do not feel

that there essentially is much competition between three, four and six-plow tractor units because physical conditions and a lot of other factors will, as far as we can see into the future, limit some farms to three-plow power units, others to four, and others to six. The problem, therefore, is not so much a question of the competition between these different sizes as it is a matter of setting up standard farm organizations and standards for organizing farms of these various types of farms. While this work has only been carried on one year, our results are quite gratifying and enough questions have been raised with this first tractor farming contact to take ten years for complete solution.

These are the kind of problems that are developing on all of the Montana tractor farms. While it is our hope that we will be able to solve some of these problems before the farmers do, at any rate, we have this satisfaction that we know about them first-hand now, whereas we feel that if we did not have this farm operation experience, we are not sure that we would fully appreciate some of them for ten years to come. Our results of this first year's work have to do more with a lot of minor specific things than broad generalities. We feel quite gratified, however, at some of our records relative to man labor and fuel consumption. By the way of illustration, I give the crop history on Field 19, consisting of spring wheat stubble spring plowed and seeded. This land was plowed with a six-plow tractor, single disked with the 14-foot single disk and drilled with the 14-foot double disk drill and pulled by a 3-plow tractor. It was harvested with the 20-foot combine. It yielded about 40 bushels per acre. The total man labor, not including hauling from the combine, amounted to 1.7 man-hours per acre, and the fuel consumption 4½ gallons of gasoline.

Field No. 6, consisting of 160 acres of summer fallow, was plowed with the 4-plow tractor pulling four 14-inch bottoms, 6 inches deep. It was next disked with the three-plow tractor using extension rims pulling 21 feet of disk harrow weighted, and duckfooted three times with the six-plow track-type tractor pulling 33 feet of duckfoot cultivators. The man labor expended on this field was 1.4 man-hours and 4 gallons of gasoline were consumed per acre.

On another field, No. 11, consisting of 120 acres of spring wheat seeded on fallow, the field labor on seedbed preparation, seeding and combining amounted to 1.1 hours per acre, with the acre fuel consumption 1.9 gallons of gasoline. This gives a total for raising wheat on summer fallow when the two are combined of 2.5 hours of man labor and 5.9 gallons of gasoline per acre.

The idea was passed on to us by our former agricultural engineering teacher, Prof. J. B. Davidson of Iowa State College, of setting up standards for these various field operations. We are at present checking the results which were secured this year on the Lone Warrior Farm with the results on some of our best case study farms. In many cases we find that they check very closely; in other cases there are wide discrepancies. We have a whole lot of new problems next year in connection with the explanation of these discrepancies.

A cooperative arrangement has been perfected between the agricultural extension service and the departments of agronomy, agricultural engineering and agricultural economics at the University of Montana, for conducting a series of about sixty meetings this winter in the most important wheat-producing communities in Montana. These meetings and this extension project are designed to increase the efficiency of the capitalistic family wheat farmer. Most of the equipment which has been loaned by the manufacturers for experimental work will be loaded on flat cars and exhibited in connection with these meetings.

These tractors or implements which we have used in the experimental work will be exhibited with placards and large photographs, etc., thereby telling the story of their experimental use during the past season and the recommendations which the college and experiment station have to make concerning them. The program will be built around the whole job of raising low cost wheat under present conditions. The extension agronomist will set forth the latest recommendations of the agronomy department with reference to wheat-cropping practices. The agricultural engineer will present material having to deal with the construction and operation of the machinery and equipment of wheat farms. The agricultural economist will set forth a number of standard farm organizations built around three, four and six-plow power units.

In other words, the problem of how to organize and manage a farm so as to make the best possible use of the land, the equipment and the resources available will be discussed in the light of our present information. We hope also that the county agricultural agents in these wheat counties will spend considerably more time in the future than in the past in extension work dealing with low cost wheat production and the operation of mechanical equipment. We expect to emphasize the necessity for accounting and better business methods in general as far as the pure business transactions are concerned on these farms.

The machinery train and this set of meetings are being operated in cooperation with railroads on an extension project which is termed "Low Cost Wheat Production." This project is based upon the case studies of low cost wheat farms as well as the survey data from 100 successful tractor farms and cost data from the case farms. Most of the county agricultural agents have formed county program committees of their best tractor farmers. The extension meeting in each county described above is dovetailed with the recommendation of the farmer program committee. It is not claimed that these programs are final; they are expected to change from year to year with new developments, but always checked up by the tractor farmer committee as representing what in their judgment represents the best program for tractor farmers.

The capitalistic family farm takes a family of better than average managerial ability, but the returns, advantages, etc., are so perfectly apparent that there is no point in any comparisons between this farm and what I call the old model pre-war family Montana wheat farm. People who have a good deal of the milk of human kindness in their make-up, who sympathize with the individuals who will be crowded out by industrial farmers, should pour out sympathy for the family who have not been able to adjust themselves to this new capitalistic family farm. They are indeed unfortunate and they are people who present a social problem worthy of careful study.

The size of most of the capitalistic family farms, or as we sometimes call them three and four-plow tractor farms, are pretty apt to be governed by the amounts of grain which can be combined by one outfit. These farms have a wide range of flexibility. They can be operated with a 12 or 16-horse team. Where there is free range available for the horses, the farm can be operated almost without out-of-pocket expense for power. The big team will do about as much work as a three-plow tractor. The livestock has disappeared since 1924 from most of the wheat farms at about the same rate the tractors have gone on farms. This family farmer can make certain farm organization adjustments in the way of keeping livestock which we doubt would pay on the large-scale farm. He can, for instance, raise corn or beans on the summer fallow, and hogs to eat the corn if he so desires. Mark the expression, "if he so desires." The common observation is that the typical mechanical-minded tractor farmer and his boy are apt not to so desire. The cases studied tend to show that those farmers who have fooled with a few old cows and hens, thereby missing their chance to farm 800 acres with a power unit, are rapidly losing out. The future fate of the capitalistic tractor farmer is largely tied up in the possibility of engineers building in the future larger power units and equipment to go with them, such that when combined with the proper amount of land, the present capitalistic farm unit becomes obsolete the same as was the case with the typical prewar small Montana dry farm.

Economic Issues of Large-Scale Farming[1]

By E. G. Nourse[2]

I ASSUME that I am facing an audience whose interest is primarily in the mechanical and engineering devices or appliances applicable to agriculture and through whose wise use our farming may be made more efficient, and that most or perhaps all of you have a strong secondary interest in the way in which such technical efficiency may be translated into the largest measure of economic success. A few of us who are present today represent a large group scattered over the country who style ourselves agricultural economists and who are interested primarily in the most efficient economic organization and operation of our agriculture and, as a necessary incident thereto, concerned in all technological developments whether in the field of engineering, genetics, chemistry, bacteriology, or whatever. A third group present here represents the practical business men concerned as commercial managers in getting their respective agricultural properties organized in both the technological and economic sense with the highest degree of efficiency in order that they may be most profitable.

As I look at it, these three groups epitomize the whole of modern economic society — the business executive as captain of our industrial world, with engineer and economist, respectively, standing shoulder to shoulder with him on either side as his two indispensable lieutenants. Science has invaded practically every line of business during the last generation or so, and progressive business executives today are welcoming men of many lines of scientific training to give them sound guidance in all those branches of their business which rest on scientific foundations or permit of a scientific approach.

In this brotherhood of scientifically trained workers collaborating in the practical affairs of life, it seems to me that the economist and the engineer have a kinship of the closest order. Both work in the field of applied science. Both aim to perform an organizing function, marshalling in the one case mechanical and in the other social or psychological forces toward the building and operation of a more powerful machine for the production of the material ingredients of our civilization. Speaking as an economist, it seems to me that the chief shortcoming of our profession has been that we have too often been content to hold post-mortems, to explain with great plausibility and minute detail just why things were as bad as they were and how difficult, if not impossible, it would be to make them much if any better, rather than to strike out in any courageous but closely reasoned program for fundamental and, if need be, revolutionary change.

We should, I think, absorb as much as we can of the engineer's point of view. He is by training and temperament a problem "wrangler." He attacks each of these problems as something new and challenging and forward-looking, something never done before or never done well enough to satisfy. How, says he, can we recombine, expand, adapt the elements of old solutions of similar problems to get a fresh and helpful answer to this particular problem? Or where can we find or whence can we develop a partly or wholly new principle by which we may conquer the difficulty?

Last winter I addressed the business men's group at the University of Cincinnati, an institution in which fields of engineering and of business have been joined probably as closely and fruitfully as in any institution in the country. Speaking as I was to a group of professional men and business executives, I used the following words:

> " . . . There is today a small voice crying in the wilderness of our agricultural problem, and it is the voice of the agricultural engineer, not merely the engineer in the technical, mechanical sense, but those others in the field of chemistry, animal nutrition, and even business organization who are engineer minded, who are ready to take an absolutely fresh look at every basic element in the problem of supplying most economically and efficiently from the soil those needs of society which can best be derived from that source and of adapting and perfecting the whole economic and social system to the carrying through of that scheme of maximum return for minimum effort."

We have been struggling for some years past with a surplus problem, one of the most distressing phases of which has been the surplus of political agitation for some miraculous way of pushing up prices. But meanwhile the sound business advisers of agriculture have been hitting

[1]Paper presented at the meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1928.

[2]Chief, agricultural division, Institute of Economics, Washington.

Efficient mechanical power has come out to the farm and permitted a stepping up of the operating efficiency of farming without resort to the familiar industrial procedure of bringing the work to some centralized power plant

We shall need much more elaborate cost studies to establish unequivocally the net economy of large-scale farming enterprises. We must measure overhead costs as they will actually develop over a range of enterprises so organized as well as the increase of efficiency obtained. These must then be checked against costs and results on the smaller units in the same regions—what may be called the big family farm.

harder and harder at the problem of pushing down costs. In this endeavor a thousand minor victories have already been won, such as better grading and packing and more efficient marketing of products, better farm management, more skillful breeding and feeding, better design of building or layout of fields, and so on indefinitely.

But are these laborious trimmings of the corners enough? The old saying has it "many a mickle makes a muckle." But that is true only in certain fields. There are some big things that you cannot get at all by adding up little ones. You must start on newer and bigger lines. You must quit oiling and tinkering and adjusting old Model T and come out with Model A.

Such a suggestion is being made for agriculture. It it proposed that we take one big stride forward by recasting our farming industry into much larger units somewhat after the manner of most other lines of economic life. Such a proposal appears to be based upon two general propositions: (1) That you need a larger unit in order to permit the installation and operation of the larger mechanical equipment involved in the scientific and engineering developments of the last few decades, or (2) that you need a larger labor and administrative organization if you are to match personnel with the labor and managerial requirements of the new technique.

Actual experiments in the large-scale organization of agriculture have moved far enough in the last few years so that we can see something of the possibilities and limitations in this direction. I take it that bringing together those who have worked in this field for the conference being held today presents a quite unique opportunity for pooling this particular body of experience. Likewise, on the other hand, efforts to increase the efficiency of farming without changing its small-scale character have been pushed with sufficient vigor by trained students of farm management during the last few years so that it should show something as to what can be accomplished by that method or where its limitations appear. My own task, therefore, will be to throw out certain generalizations or points of view which come to me from my economic analysis of the problem itself in the light of such observation as I have been able to make of efforts to organize farming commercially on a large-scale basis.

Mechanical Efficiency. My first proposition is that strictly from the mechanical side agriculture does not present an imperative demand for large-scale farming at all comparable to that of industry or mechanical pursuits such as transportation. No time need be consumed to set forth the imperative necessity of operating a modern railroad, steamship line, steel mill, or automobile factory as a large business unit. In every case the mechanical requirements of the assembly line system, the importance of performing a succession of processes without allowing metal to cool, the requirements for terminal handling and through hauling of freight or passengers, and the unit size necessary for vessels rendering modern types of service mean that you must either have a very large unit plant or you cannot carry out the processes made possible by modern invention and constructive genius. If I may pass this as something to be taken for granted by this audience, we may well pause to ask the question how far similar requirements predispose agriculture toward large-scale development in the future or, on the other hand, how far the balance between the technical character of a soil, rain, and sunshine industry and the equipment that the engineer has designed to serve it requires anything more than a family-farm type of economic organization.

The Industrial Revolution which is still evolving the wonders of our manufacturing industry proceeded in the main on steam power, and economical steam power demands comparatively large plant units. The smallest steam engines were so big as never to get more than a precarious and limited foothold in agriculture. The gasoline engine in the present and perhaps to a rather important extent electric power in the future, quite reverse this pull. Stationary engines and motors, tractors, trucks, automobiles, and auxiliary gasoline engines mounted on tractor-drawn implements permit a high degree of mechanical efficiency on even the small farm. The mountain has come to Mohammed and thus saved the prophet the toil and humiliation of going to the mountain. Efficient mechanical horsepower has come out to the farmer's barn and shop and fields and thus permitted a stepping up of the operative efficiency of farming without resort to the familiar industrial procedure of bringing the work (so far as farm processes could at all be brought) to some centralized power plant.

But here a question arises: Does the efficiency of these small power units in the hands of the rank and file of farm operators, widely scattered over our agricultural domain, fall to so low a level that important results can be accomplished by building them up into some larger scheme of operation? In the earlier, less foolproof days of the tractor the answer to this question seemed distinctly, Yes. Since that time, however, the farm implement manufacturer has so radically improved their quality and the method by which they can be serviced in shops equipped with the necessary machinery and manned by well-trained mechanics that in this day of swift automobile transportation it would appear that decentralized operation of farm processes probably falls but little below the level of efficiency which could be secured under centralized management.

This, however, answers but one phase of our question. The coming of the tractor and power-drawn and motor-operated implements to the farm is only one part of the story. Machines for saving labor and performing processes which could not be done by hand have invaded many parts of the field that was called agriculture and gradually removed from the open country many processes which formerly were performed in farm buildings by farm workers and were thus classed as part of agriculture. Such processing today goes on in more or less remote packing plants, canneries, mills, creameries, or other factory-organized enterprises.

One of the most recent developments in this connection is that of the commercial hatchery, which has become a distinct factor in increased efficiency of poultry production. In the comparatively few years since artificial incubation was introduced, we have passed from the farm-size hatching machine to specialized incubating plants, which first seemed large when they had a capacity of a few thousand eggs but which are now by no means uncommon in sizes of one hundred or several hundred thousands, and in the case of one plant in the Petaluma district of California has attained a capacity of nearly two million eggs. This illustration of the development of a large unit of mechanical equipment is particularly pertinent because of the fact that it has permitted a very high degree of centralization of a particular function of a type of farming where close personal attention to delicate young animal life is important and has thus checked an incipient tenden-

cy toward consolidation and growth of large-scale operations in the business as a whole.

A similar illustration is to be found in the horticultural field, where the technical requirements of spraying or fumigating, possibly pruning and in many cases harvesting, have led to the specialization of these particular functions by cooperative organization of these parts of the work or their performance on a custom basis while still leaving the actual production units so small as readily to be handled as individual family enterprises. Over against this, however, we should remember that in particular instances there has been a distinct increase in the size of both orchards and poultry plants operated under a single managerial control and not infrequently set up in corporate form.

The point, however, which I wish to stress in this connection is the aggressiveness of non-farming interests to set up and operate hatcheries, canneries, dehydrators, storage plants, and the like in small towns scattered through the producing territory and their zeal also in bringing to the operative farmer such other services as require a large or expensive equipment of a mobile sort which can be brought to his farm or ranch. As a result we must admit a very considerable narrowing of the field within which it can be said that the necessity of owning, equipping, or operating the mechanical plant positively and unequivocally demands an enlarging of the size in order to attain if not maximum at least profitable efficiency.

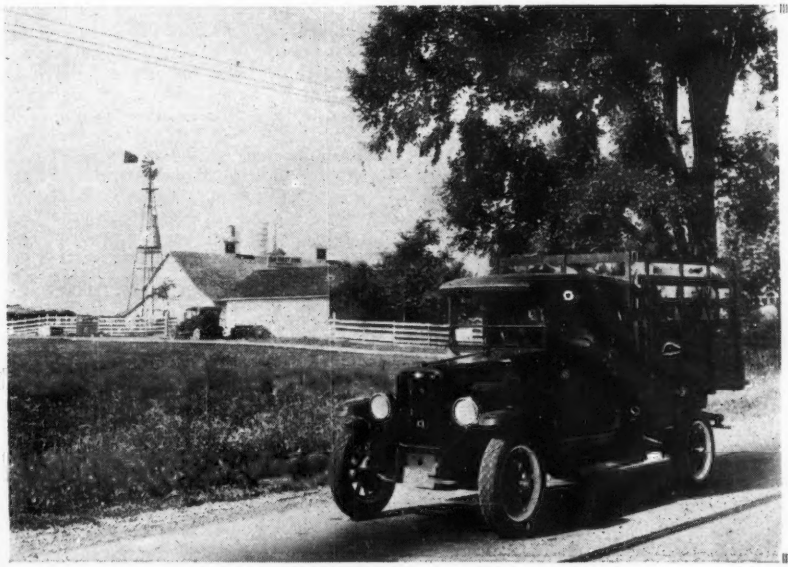
Labor Specialization. Obviously it is not possible fully to separate the man from the machine in this discussion. Even though the implement manufacturer is building tractors and other machines of high-grade mechanical efficiency capable of economical operation on a family-size farm, the question still remains unanswered whether these potentialities are actually being realized with the sort of labor to whose hands this machinery is entrusted. In other words, our inquiry shifts from the tractor to the tractioneer.

I suppose that we may concede that American farmers by and large, both natives with their Yankee ingenuity and immigrants of the intelligent types which mostly have come into our agriculture, get away in pretty good shape with the almost foolproof machines which are being put in their hands today. But even so, that kind of operation, where general farm-hands are the mechanics and simply "pick up" their trade, would by no means meet the standards of efficiency demanded in modern industry. No, industry has grown up under the principle of division of labor and demands special training and expert supervision of workers selected for their natural aptitude for the task.

Must we then have farming organized in units large enough to sort out and train a superior few from this great body of semi-skilled mechanical workers on the farm, train them, and systemize their work under master mechanics, inspectors, and repair-shop foremen, garage bosses, or whatever you choose to call them? My answer is that while we must not ignore the industrial principle of division of labor we must very drastically modify it in our application of it to agriculture.

In the case of one-crop farming near the extensive margin of cultivation we shall doubtless have some operating units which go far in the direction of a factory system of handling machinery and machine labor. On Thos. D. Campbell's farm, for instance, harvesting outfits go in fleets of four, each group trailed by a master mechanic ready to render assistance to any outfit which gets into difficulty. This is backed in turn by a central power-equipped shop in charge of skilled machinists and other workers. In it have been developed some striking methods of economical operation and maintenance under Mr. Campbell, who is himself an engineer by profession. One need not question the technical advantages of such a set-up. It is fairly obvious also that this type or organization grows naturally out of the character of farming and the geographic situation presented in Montana and to be found likewise in other sections, such as the Southwest wheat belt, where also large-scale enterprises have developed. We shall need much more elaborate cost studies, however, to establish unequivocally the net economy of such methods. We must measure overhead costs as they will actually develop over a range of enterprises so organized as well as the increase of efficiency obtained. These must then be checked against costs and results on the smaller units in the same regions—what may be called the big family-farm.

This is the point which the economist is bound to lay unpleasant stress on in the midst of these pictures of high efficiency, namely, the high cost of the highest efficiency as compared with the very moderate cost of comparatively high efficiency. My own observation leads me to believe that the degree of efficiency attained on the big power farm under something resembling factory methods can be practically duplicated in a very large part of our well-developed farming country at a cost as low or lower. This would mean only a very moderate stepping up of the size of farms as we now have them in farming sections which have advanced to the stage where power farming has been known long enough so that the rising generation has grown up in it during the past decade or so, and



Motorized transportation is one of the most important contributions the engineer has made to more efficient agriculture. This is especially true in large-scale operations

where the population density is sufficient to bring within easy automobile reach of the farms towns of enough size to be equipped with adequate service stations.

The fact that over most of our agricultural territory a very moderate reorganization of the family farm is sufficient to produce the needful degree of labor specialization at no increase of labor cost is being demonstrated over and over again. Such specialization would touch several branches of the technique of farming, but we will illustrate it here simply in its mechanical phase which we have already been discussing. For this let us take the case of the farmer's boy who derives from the agricultural high school, the winter short-course, or the regular collegiate agricultural training such a drill in machine construction, operation, and repair as will make him an entirely adequate mechanic for the farm under present conditions of machine design and servicing facilities. Many an ordinary hired man is traveling this same road without becoming a union machinist or advancing his wage scale to a point that burdens the farm budget. If one considers the rapidity with which the implement manufacturer and the farm labor force have got together on this proposition with the implement dealer and his service station as the intermediary, it gives us much reason to think that the farm needs only to become a three or four-man farm to permit of a labor specialization which will approach maximum efficiency in the utilization of modern mechanical equipment on the same basis of labor cost as now obtains for farm work.

Commercial vs. Mechanical Phase. When we turn from the mechanical to the commercial demands of agriculture, the picture changes rather markedly. The small American farmer characteristic of the past is showing himself by no means adequate to the growing complexities of the modern commercial situation. He is baffled by the problem of planning production wisely, purchasing equipment and supplies intelligently and economically, selling his product with good judgment, and financing the whole operation soundly and economically. Under our system of small independent proprietorship there is practically no specialization in the handling of these problems.

The man who makes business decisions may be one highly endowed with aptitudes for the tinkering of machinery, the production of bumper crops, or the skillful breeding or feeding of livestock rather than grappling with the intricate problems presented by farm business management under present-day conditions. Merely in accordance with the law of averages, we cannot expect that in any large number of cases the directing farmer will have any particular flair for business or that he would put into operation any adequate system of accounts or be able to analyze and interpret the results even if he should carry through the labor of keeping the records. We could hardly count upon them as a whole to judge soundly the productive value of real estate under changing conditions of general business or factors affecting their locality specifically. Nor would they be on the watch for cyclical movements affecting their business and guard against them by the accumulation of reserves safely invested. Beside any lack of natural aptitude or special training along these lines, the circumstances of the farmer's residence and character of his calling practically preclude his informing himself adequately as to the business conditions upon which sound judgment must from time to time rest.

At the present time almost two-thirds of the workers engaged in farming are in direct control of the business unit in which they are employed. It would seem a self-evident proposition that in no field of human endeavor could it be expected that leaving managerial decisions to two-thirds of all the workers could result in anything but inefficiency almost medieval in character. Here, I think, is the real economic demand for large-scale organization in agriculture. We must have the function of management differentiated from that of the actual operative processes of the farm if we are to take advantage of the technological possibilities which lie in the path of modern scientific and commercial agriculture. How fast and how far we can move in getting it is quite another question.

Two possibilities appear to be open. One is by the slow creeping method of a very gradual growth of larger farms in which such owners as have a natural business bent enlarge their operations, employ workers of specialized abilities and training to direct different phases of the farm work, and limit their own activities to management, marketing, financing, the keeping of records, and the analysis of accounts. Scattered instances of this method of farm reorganization are evident today, but a very well-informed and sound thinker in Iowa suggests that in that state the number of men capable of directing even an enterprise of such size "could be counted on the fingers of not very many hands." Personally I think that this is a rather exaggerated statement. But suppose I say, "Why there are hundreds in a state like Iowa." I really believe there are. Still there are nearly 210,000 farms in Iowa. If we are talking of a consolidation which would bring ten workers into each operative unit we should need to have more than 20,000 managers of the sort indicated, and the most optimistic would not suppose that there were 20,000, 10,000, or perhaps even 5,000 really competent managers of ten-man farms in Iowa.

Given such a moderate degree of concentration as would bring farm operation into the hands of a smaller but selected and specially trained group of managers, the possibility of perfecting our system of rural credits, our machinery for more efficient group marketing, and practically all of the commercial and financial phases of agriculture would be enormously increased. Agriculture is one of the industries in which a comparatively small operative unit permits of maximum efficiency and indeed is largely demanded for such efficiency. Theoretically such individual operation can be joined with an efficient performance of

Large-scale farming will more and more create a demand for suitable implement and machinery units for use with the larger power units now available

other functions which call for group action under cooperative patterns of organization such as are being so vigorously pressed in the United States today. To a certain extent cooperative organizations permit of economy and effectiveness in the purchase of supplies and the sale of product. But such facilities are by no means universally available or well-managed. In practice, the organization of these group activities falls very much short of its theoretical possibilities just because of the fact that the cooperative must deal with an unconscionable number of small, ill-trained, financially precarious individuals who cannot be brought into alignment and kept in alignment long enough to accomplish the major objectives of the organization. In proportion as the conduct of actual farming comes into the hands of a quarter or a tenth of the number of independent farmers employing helpers on the basis of specialized efficiency will the task of group organization of commercial and financial functions of the business be strengthened and simplified.

To me the pertinent question is: Are we going to try to retard or to promote this line of development? Are we going to go aggressively at the training of farm managers and the stimulation of such consolidation of operating units as will permit of reasonably efficient management joined with a fair degree of specialization along the major technological lines? Or, on the other hand, shall we continue to direct our whole system of agricultural education toward turning out jacks-of-all-trades and direct our energies toward saying that the farmer shall not lose one whit of his separateness, individuality, and much-vaunted independence?

Let us turn now to the second type of business reorganization which has been proposed for the economic strengthening of our agriculture. Here, instead of proceeding by the slow method of gradual growth from existing small units, agriculture is urged to make a clean break to the system of large units and corporate organization. It is not very difficult to sketch out on paper the manner in which a rather dazzling condition of labor specialization, managerial competence, rigorous accounting, skillful financing, and efficient marketing could thus be carried out. In the present day of the telephone, automobile, truck, and tractor, the geographic limitations upon the centralization of agricultural operations has been very much weakened. While one has no more than opinion to back the assertion, I am myself confident that we shall see an increasing number of large-scale operations in agriculture and that the movement toward so-called corporation farming could readily progress at a rapid rate were the difficulties in its way merely of a technological character. That is, as a mere matter of plant and office management it is ridiculous to assert that agriculture is too tough a nut for the corporation to crack in this day of consolidation of railroads, factories, bakeries, milk distribution, cleaning and pressing, and even beauty parlors.

The real difficulties which will, I think, prove a definite and rather drastic check upon any considerable expansion of really big farming operations under the egis of the corporation come not in the way of operative difficulties but on grounds of costs, prices, and competition. All three of these are but phases of a fundamental weakness of agriculture as a field for promotional development. In the first place, any pronounced success of such a move would on general principles and on the historic evidence of other industries lead to an increase of production. Even though this were accompanied with such decrease in operating costs as we have suggested above, the situation would afford no parallel to that of industry for two reasons. First, the decline in costs could not in the nature of the case be at all comparable to those of industry in which we pass from a stage of almost experimental manufacture of a new device in small quantities to that of mass production under a perfected system. Agriculture is too old an industry and has been too well exploited under existing methods to offer any such field of conquest to the corporation however well managed it might be. In the second place, these other industries have thrived by expanding their market through plying it with goods of better quality or of greater variety on a descending scales of prices. Here again, the market for agricultural products is essentially inelastic and already so fully served both in terms of quantity, quality, and variety as to offer a comparatively unfavorable field for this type of commercial exploitation.

So much for prices. In what has already been said, we have expressed one opinion as to the possible extent of the lowering of costs. One other observation seems in line, however. The increased efficiency which would come from better management and more able and highly-trained supervisory agencies would put agriculture in competition for technicians and executives already paid in other industries at a scale grossly disproportionate to that in agriculture. In other words, diminishing operative costs would be accompanied by mounting overhead. The statement is frequently made that agriculture cannot stand any such overhead. This, I think, is a statement which is true or not true depending on the sense in which you take it. Obviously any branch of agriculture which could be organized on a basis of comprehensive control could afford to pay for such overhead as resulted in increased efficiency just as any other industry dominated by corporate organization can. From the standpoint of the economist such wages are quasi rents and as such not to be figured in the ordinary cost of production. The sense in which the statement is true, however, is that even corporate agriculture would still be subject to the competition of farmers who supply management not of the maximum efficiency theoretically obtainable under a well-managed large-scale organization but of a very high practical quality without charging for it on the basis on which prices are made in the competitive market for managerial services.

As I said before, these three propositions fade one into the other. Then we find ourselves now in the third phase of the discussion, namely, the weak competitive situation in which corporate agriculture in general would find itself. In the first place, it could not monopolize natural resources in the rather strict sense that the aluminum industry does or even in the relative sense of the steel corporation, the railway, or the telephone company. The strength of such concerns rests to quite an extent on their dominating position with reference to resources geographically limited or their operation of facilities of such gigantic size that no one else can compete with them until he can enter the field with a plant and organization substantially as large as theirs. Conceivably such a situation might come about in such a branch of agriculture as cranberries, lemons, or other specialty products, and I think it entirely possible that our children or our grandchildren may see situations of this sort developing. During our own lifetimes, however, I anticipate that the growth over agriculture as a whole will be quite slow and that this will be particularly true with reference to the great staples which can be produced efficiently over a wide geographic range with comparatively small equipment and no great degree of specialized ability. The fact that the modern type of large-scale business organization already dominates the business by which such products are processed, stored, and marketed, and that the plants of these organizations already come to the farmer's market, town, or even to his farm gate means that it is only the initial stage of the process of furnishing consumers' goods which lies in his hands. This is a process so easily open to almost anyone that it makes an unmanageable type of competition, not merely in terms of economic cost but almost emphatically in terms of offering prices with which the strictly commercial organizations would have to compete. From the standpoint of the business executive looking for dividends on capital, this is "cutthroat" competition. From the standpoint of the salaried or wage worker on his payroll, it would be "scab" competition. But it is something which is inherent in the nature of the industry, and something which the corporate promoter turning his eye toward this unexploited industrial field must not overlook or under-estimate.

Ten Years' Experience in Manufacturing Wheat on 100,000 Acres[1]

By Thos. D. Campbell[2]

I SHALL undertake to tell you of our experience in the manufacture of wheat, flax, and other grains. The industrial production of crops is not entirely new. It began ten years ago with us. Since then we have attempted to raise crops on the largest scale. No doubt all of you have heard of some of the famous wheat farms in the Red River Valley. The old Dowling farm is as famous as the United States Steel Corporation. It was a success. It had business management from the very beginning. It adopted industrial methods. But some of the greatest problems we have before us today they had then.

We have tried to operate on a large scale as long as I can remember. When I was sixteen years old we operated a large farm near the Red River Valley and I was responsible for its operation at that time. It is not comparable to some of the large farms today, nevertheless we had 7,000 acres. We attempted to use the machinery we had at that time. Steam engines were quite well developed and we were using them. We tried to design hitches and attach larger loads to these engines, using the old equipment designed for horses. And we ran into the same troubles then which we have been experiencing during the last ten years, namely the utter impossibility of attaching equipment designed for horses to a tractor. The maintenance of the equipment and the breakages and replacements were tremendous, as they are today.

The steam engine, as you know, had a splendid development and reached a very high point of excellency. But when the internal-combustion engine was placed on the market, immediately all these high-grade steam engines were discarded. They were efficient and good, but they were obsolete and no one could afford to use them any longer.

As in every other line of development we learn by our experiences. We started about ten years ago to develop a large area of land along strictly industrial farming lines. The idea of industrial farming came to me when I was a boy in North Dakota, primarily as a result of the hours of toil and labor of my mother and all the other pioneering women in that vicinity. I know from my experience that with our limited area of rainfall, the high freight rates, poor marketing conditions, and all the other things with which we had to contend, we attained our success because mother and all of the children worked eight hours twice a day all their lives for nothing. If they had been given ordinary compensation, there is no 160-acre farm in the entire west which could have met the first month's payroll.

It is not strange that people seeing those things get a desire to improve them. Fortunately my people were progressive enough to give me a good education. I am not in any way bitter towards agriculture, for everything we have today came from our wheat farm in North Dakota. But as I went east to college I saw the development of industry, and I learned it took more power to operate the farm lands of the United States than all other industries combined. I realized there was a great opportunity for some mechanical engineer to apply industrial methods to agriculture.

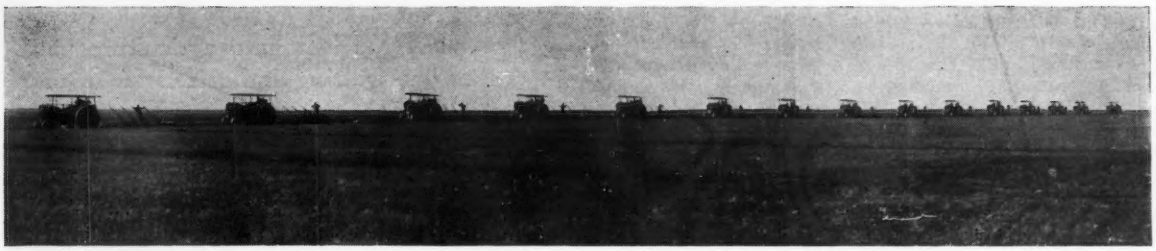
Now we have learned in the application of this idea that first and foremost we do not have to do any experimenting along agricultural lines. We have the U. S. Department of Agriculture, the various state agricultural colleges, and the farm bulletins which contain the results of years of experimenting which are infinitely better than we could hope to produce ourselves. I could take a bulletin from any agricultural college or the Department of Agriculture, prepared by men of ability, and learn more about the production and fertility of the soil, what to plant, how to plant it and the amount to plant, than I can learn in experimenting fifty years myself. It is much better done than we could do it, because it is done under the supervision of the government; it is done in a scientific manner. Imagine a farmer himself having a series of a hundred or more plots with different depths of plowing, different ways of seeding, and different varieties of seeds!

We have also learned we must have good machinery. Practically all the industrial failures I know of, even within the last ten or twenty-five years, can be attributed to a large extent to the machines we have had to use. Manufacturing plants have gotten after their production men and have insisted each year that the tonnage of steel be

[1]Paper presented before a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1928.

[2]President, Campbell Farming Corporation. Mem. A.S.A.E.

This picture shows one of several harvesting outfits used by the Campbell Farming Corporation in Montana. The grain is cut (but not bound) and placed in windrows—four binder swaths in one windrow. It is later picked up and threshed with the outfit shown on page 3



These fifteen 30-60-hp. tractors, each hauling an eight-bottom plow and disk harrow, plowed and disked 640 acres on Mr. Campbell's farm-factory in one day without a stop for mechanical trouble of any kind. So far as is known this is a world's record

reduced in our machines until we have had castings put on agricultural machines which were so weak, if we had had a quarter of a pound more cast iron in each one, we would have saved probably a twenty-mile trip to town for a repair part and a whole day's shutdown.

The manufacturers had the wrong idea. They had the notion the farmer wanted something cheap. That is not true. The farmer wants good products just as well as the people in other industries.

We have also learned it is very necessary to have economical units. That is nothing new in industry. Industry learned years ago it had to have an economical unit. And we know an economical unit in agriculture is in direct proportion to the rainfall. There are many, many factors entering into it, but the great big factor is precipitation. We have found out in order to succeed on a farm in the great plains area, where we have an annual precipitation of 15 inches, that a unit of 2,000 acres is the minimum acreage which you can operate economically. And in three or four sentences I will explain that to you in a very conclusive way.

Right after the Civil War our government began distributing land in lots of 160 acres. And 160 acres became planted in everybody's mind as the proper size for a farm. Now 160 acres of land in the great plains area under the most efficient operation and most favorable conditions will earn approximately $2.50 per acre net, that is, with a rainfall of 14 to 15 inches. Now any man, who can go out and operate 160 acres of land, can in these modern times earn about $1650 in the city at any kind of a job, working on the streets, hauling cement or coal, or anything else.

Now in operating 160 acres of land the farmer starts out the very first season with an overhead of $10.00 an acre. And all he can earn under the most favorable conditions on this 160 acres of land is $2.50 per acre, which is $400.00 a year. He had better take a job in town at $2.00 a day. He could earn more money. As you can see it is economically impossible for him to succeed.

Now take 2,000 acres at a dollar an acre. We have found that a dollar an acre is all the farmer can earn on an average on 2,000 acres. As the rainfall increases that curve shows a little higher possibility, but we know that with a 2,000-acre unit over a period of ten years it will pay more money per capital invested than any other conservative business you can go into. We have also plotted curves for other parts of the country, but I will only quote one as they become rather tiresome. Our curve shows that the minimum economic unit in Iowa, where the rainfall is 29 inches or more, is 640 acres. That means you can take almost any four quarter-section farms through this section, make one 640-acre farm, eliminate almost three sets of buildings and almost three groups of equipment, and you can afford to pay your manager $2,500 to $3,000 a year and your overhead will not exceed three, four or five dollars an acre. And you start out with success written in the first line, because you have got efficient management; you have got a man with brains and ability to do the job, particularly if he is an engineer.

Farms must be properly located the same as a manufacturing plant. You must locate a farm with the same degree of care that a hydroelectric plant is located. The same government gives both the rainfall records. Labor is not as easily developed but it can be taken into consideration.

But in connection with all this you must have trained management, and you must make up your minds to pay high wages. It is impossible for any farm enterprise anywhere, large or small, to get skilled men, just because it is a farm, at less wages than those men can earn in town and live in town under more comfortable circumstances. You cannot except the boys and girls to stay on the farm when they can go to town and earn more money with more comforts. So we must arrange it so that the farm laborer can earn as much as his skilled brother in the city. And when you do that, you will get them back on the farms; they will flock back by the thousands. Men come to our job from everywhere, because they can earn more money there over a period of nine and a half months, with high wages and a mileage bonus basis, than they can earn in almost any other skilled labor job in town.

We have had to face a very difficult obstacle, that is, getting sufficient capital. You can get practically all the money you need for any other kind of business in the world except farming. Why? Because people don't believe in farming. Recently the average daily loans in New York City to brokers amounted to over five billion dollars. It all came from the same money source, the Federal Reserve Bank. But the farmer cannot borrow five hundred million from the same source to hold back his crop and market it orderly.

We have learned it takes approximately $10.50 per acre for machinery investment to have efficient production. That sounds like a great deal of money, doesn't it, especially if you are operating land which you can buy for $5.00 an acre? (Some of it you can buy for $3.00.) The reason that investment is so high is due to the fact you must complete your work within the season. Farming, in addition to being a merchandising business, is a form of contracting business. Some of you men who are engineers have had contracting experience, and you know what it means to have a bonus or penalty clause attached to the contract. You get a big bonus if you get the job done before a certain date, and you get a terrible penalty if you don't. But after all, all the penalties which have ever been added to a contracting job for completing a building on time are very mediocre and small as compared with the penalties the farmer experiences if he doesn't get his job done on time. There is no business in the world which penalizes you as much as agriculture, if you don't get your harvesting finished before the fall rains commence, or if you don't get your plowing done.

When you undertake industrialized farming you get into accounting. I spoke yesterday to the Agricultural Commission of the American Bankers' Association. A banker who spoke emphasized the necessity of accounting systems and budgeting in farming. He said if the farmer could come back with a statement of what he needed and what he had spent and earned, the bank could

analyze that statement and he could more easily get credit. That is true. I bank in Chicago. I prepare a budget. If my budget is properly prepared and I can show a reasonable profit, I do not have any difficulty in getting any funds to carry on our business. You cannot have a system of accounts without having a budget.

The time is coming when we will have a recognized system of accounting for the farmer, which will be as regular and as standard as the credit statements which the bankers ask you to make out when you apply for a loan.

Now we have a job. We are looking for some other ways of solving our farm problems. And like every other manufacturer or producer of any commodity, there are three things we can do. The manufacturer either has splendid tariff protection, he reduces his output, or he reduces his cost of production. There is no large business in the United States today with the possible exception of the maintenance of our great railways and the field operations of our great oil companies, which offers the opportunities in the cost of production that there is in farming. I do not know of any one thing that is such a big factor in solving the farm problem as the use of engineering and management in the cost of production. We have accomplished some results on our job which have astonished ourselves. We can operate an acre of land over a period of twelve months for $8.00 an acre, including the rental we pay and the overhead.

A greater part of that has come from the use of the combine harvester. There are so many objections to the combine that people are constantly bringing up, but none of them are sound. There isn't one objection to the combine today that an experienced farmer can't solve. He can solve it either by using the windrow method, or if that isn't sufficient he can put a drier in the combine. We have developed a combine drier which will reduce the percentage of moisture one per cent at the time of combining. R. H. Black of the U. S. Department of Agriculture says the surface moisture on grain is the serious thing; it causes more damage than anything else. We use the exhaust from the engine, which operates the combine, to dry the grain. Sometimes that is not enough. But two gallons of kerosene will burn up all the wheat you can put through the combine in a day. The maximum safe temperature at which you can put wheat through is 220 degrees F.

But with all these and some other things which others are working out, there are many more we still need. First, as I emphasized a few minutes ago, we need better machinery. Our manufacturers are striving in every way to furnish it. The manufacturers who are really concerned are not putting machines out on the job which have not been thoroughly tested. We have on our job tractors which are going through their third season and which have not been put on the market yet, but when they do go on the market I think all of the weak points will be found.

We must get different kinds of tractors. Somebody sometime soon is going to develop a Diesel motor for tractors. It is just as inevitable as the sunshine. When it comes it will be a tremendous factor in reducing costs. And we must have different ideas in the application of power. Plowing is the heavy load in agriculture. A tractor which will pull a certain number of plows will pull a much larger area of any other tool. The great consumer of power on the farm today is the plow. We are still using plows on a tractor which develops about 45 per cent of its horsepower at the drawbar. We pull plows now with tractors because we used to pull them with horses. Why don't we put some kind of pulverizer on a frame to chew up the soil and pulverize it? Then we could pull that machine over the ground with much less power, and much faster. There would only be the rolling friction and the grade.

That same principle is carried out in combines. There was a time when the power to operate combines was obtained direct from the ground. As a consequence we had a variable speed. We would hit the horses a little tap, they would walk a little faster, and the grain would all go out with the straw. Now we have uniform power because the combines are driven with individual engines.

"When you look into agriculture you cannot help getting enthusiastic as to the possibilities for the engineer. There is no opportunity today equal to that which the agricultural engineer has before him."

Thos. D. Campbell

That is an old story, but it is very essential to agriculture. In agriculture more than in any other industry there is a great opportunity for the engineer. I know we have genius and ability enough in our profession to develop some new kind of a plowing tool. We are using practically the same tool as the natives used in the valley of the Nile when the Pharaohs built their pyramids. We still have about the same shaped plows as their old wooden plows. We get a little better material today; that is about all. But the modern plow could be made much better. The modern plow share made of crucible steel with a soft center costs about $4.50. During the dry season we have to change those shares twice a day, or we cannot keep the plows in the ground. In most places it costs 75 cents to sharpen them, and repointing is $1.50. So the cost of plow shares alone is nearly $1.00 an acre.

Why can't we have a plow share made out of high speed tool steel? If we can make a machine which will take a piece of steel and cut off an area an inch square for 1,000 feet and keep its temper while it is red hot, why can't we get some better material in a plow share? It would seem to me that we have some metallurgists in this country who could give us a plow share that would at least cut dirt for more than six hours. We tried to solve it by putting stellite along the cutting edge. It is a very good material. Of course, that necessitates a grinding job, but the plow share will last many times longer than it would otherwise.

It is hard to investigate agriculture without becoming too enthusiastic as to the possibilities that are present for the engineer. I know that there is no opportunity in all creation today equal to the opportunity which the agricultural engineer has before him. I have stated many times that there is no industrial opportunity in the United States equal to the opportunity in industrial farming. There is no capital investment which you can make today which will yield as big a return over a period of ten years as industrial farming. I mean conservative business; I am not talking about novelties and patents and businesses which have a high rate of income for a short time.

I want to leave the thought in your minds that you have the same opportunities engineers have had in other industries to get your name in the Hall of Fame. You have before you an opportunity to solve the greatest economic problem, not only before the United States, but before the entire world.

And another thing, I want you men as agricultural engineers to think more of the mechanical side of your profession and get the agricultural side from the Department of Agriculture and the state agricultural colleges.

Group Management of Corn Belt Farms[1]

By J. M. Dowell[2]

GROUP management of corn belt farms is coming about through the dissatisfaction of land owners with the system of farming which they have heretofore employed. It can only hope to expand and ultimately survive through results obtained. Results will be judged on a basis of profits.

Profits to the land owner need not be in the form of immediate cash. They may accrue and be shown as an added investment in part or in whole. It usually takes time for profits to show as cash. By time we mean from two to ten years. As a matter of fact, for many years most farms have gradually been robbed of fertility.

A system of farming that will replace this fertility may not show net cash returns to the owner during the process of rejuvenation. The land owner's part of the income may largely be reinvested each year for a period of as much as five or even ten years. The investment will be in the form of tile, limestone, phosphate, fences, buildings, clearing of stump land, etc. The operator or tenant, however, takes out additional cash income practically from the start.

A farm can be likened to a factory. Strip the factory of just the latest labor-saving machinery—it can go on perhaps, apparently in pretty fair shape, but not at a profit. Many farms have gradually been stripped. Not one Midwest farm in ten is in really good physical condition as regards soil tilth, fences and buildings. As a result net profits are often inadequate.

The job of the farm manager, of the agricultural efficiency expert, if you please, who assumes complete management or who supplements the work of resident managers, is to devise ways and means of placing the land on a "long time" profitable income-producing business basis.

It is easy to add 25 to 50 per cent to the productive value of the average corn belt farm. Values of land with which we have been in touch can, in a number of cases, be practically doubled under proper management over a period of, say ten to twenty years. I refer to land value from an income producing standpoint.

It is not at all necessary to double crop yields in order to double the net income. But it is necessary to do several things.

Suppose, as a simple example, an average farm is capable of a net profit in terms of corn of 10 bushels per acre for the entire acreage. This is likely to indicate that the average yield must be about 50 bushels assuming it costs the equivalent of 40 bushels to take care of all the overhead of investment, taxes, upkeep, labor, etc. Add the equivalent of 10 bushels per acre per year in cost of production, in the form of the proper drainage and soil treatment as limestone, phosphate, etc., where needed legumes, livestock, seed selection and treatment, etc., and the yield will ordinarily go up to around a 70-bushel basis, showing a net of twenty instead of 10 bushels. The value of the land is then doubled from the standpoint of ownership or net income. References to Illinois Bulletin 300 regarding "Lessons from the Morrow Plots" verify the above.

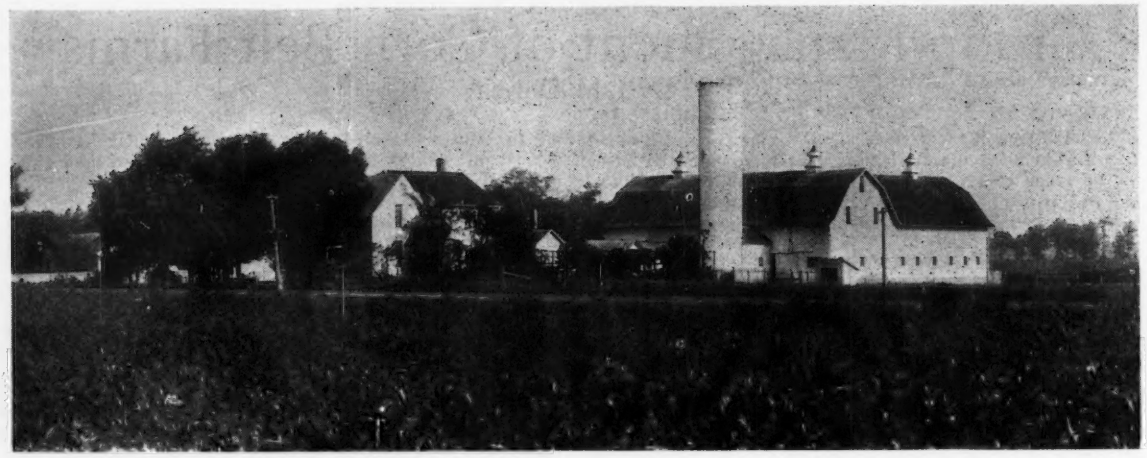
The Morrow plots at Urbana, Illinois, are the oldest in America, having been in continuous operation since 1876. They are located on some of the best soil. Today some of these plots are worth more than double others from a production standpoint. It is shown, for example, that the best plots are getting soil treatment costing $6.74 per acre per year (about the value of 10 bushels of corn.) And yet these plots return $34.49 per acre (average 1916-1927) above cost of treatment while the corn and oat plot with no treatment returns only $17.39 per acre. The corn, oat and clover plot has returned an average of $24.35. Thus it is seen that net returns with proper rotations and soil treatment are practically double the corn and oat plot and more than double the straight corn plot that yields an average of only $15.89 per year, which is less than cost of production.

Group management makes it possible to employ a graduate farm manager, who can do exactly what has been related. The average farmer (owner or tenant) has neither the time nor the technical training to study and ana-

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1928.

[2]General manager, Do-Well Agricultural Service, Champaign, Illinois.

Deprive a factory of the latest labor-saving machinery, and while it can go on producing and continue to exist, it cannot make a profit. The same is true of most farms. Mr. Dowell says not one Middle West farm in ten is in really good physical condition as regards soil tilth, fences and buildings, and as a result profits are not adequate. It is the job of management to put these farms on a long-time, profitable business basis



The average farm owner or tenant has neither the time nor the technical training to study and analyze all the problems confronting him. His primary job is production. Group management has proven the solution of this management problem in many cases

lyze all the problems confronting him. His primary job is production and that problem alone is so vast he is constantly in need of expert guidance.

We are always reticent in the matter of taking over efficiency studies or complete management work on land when the owner states that he expects immediate increase of cash in hand. Such a system can only lead to disaster. It is merely a high-class method of additional soil robbing—half to the owner, half to the tenant and nothing to the land. It is easy to increase the income, but much of the owner's share of the returns for a few years, from a purely business standpoint and on a long time basis, must be returned to the farm as added investment.

In order to quickly place neglected farms on a profitable basis it is often advisable, where possible, to invest the first few seasons even more than the cash returns. Lack of capital handicaps most farming operations. Assume a farm is worth $100 per acre. Through additional investment of even as much of $40 per acre it is very often possible to double the result-getting value of the property. In other words, a farm manager can quite frequently work to the best advantage of the land owner through recommendations which require additional investment, rather than addition removal of cash from the enterprise.

Practically all successful businesses employ from time to time the services of efficiency experts who earn many times their fee through the formation of plans and recommendations which ultimately increase the returns. We are specializing along this line of endeavor as applied to land and have done efficiency work, supplementing the regular management on a number of the large Midwest tracts of land. This work seems to fill a real need and our operations along this line are rapidly expanding, covering more than 15,000 acres during 1928.

Experience shows that merely a rearrangement of rotations may increase net income an average of $1.00 or more per acre per year. A complete agricultural engineering survey and mapping service such as we make, showing field areas, etc., combined with a complete acidity blue print (in four colors, according to the degree of acidity) has been shown to be worth another dollar per acre per year to the owner. The necessary fee in such instances is a very small percentage of the profits accruing therefrom.

Follow-up services in connection with our partial management work which supplements that of resident manager, say, four inspection trips per year, have also proven to be of real value. Otherwise it is so easy for a farmer to lapse back into the old non-profit rut or to overlook many opportunities that arise in the soil-building program from season to season. No two farms are exactly alike.

Wide experience and many inspections along this line of work make it possible for an agricultural efficiency organization to quickly grasp conditions and to make recommendations accordingly. We have been able to double the net income the first year. This, of course, is the exception and not to be considered the rule.

One of the things which a farm manager can do and which the owner or operator is likely to neglect (at least in part) is to check up and insist upon the constant employment of modern farming practices. These items include selection and testing of seeds, proper preparation of seedbed and cultivation of the crops themselves. Also the livestock operations need constant supervision as regards handling of the stock, marking, docking, dehorning and balancing the rations. This last item is too often sadly neglected and in itself may eliminate all profits from the operations that might otherwise be possible.

One of our special means of keeping our farm operators and tenants informed and guided is through a publication we issue once a month, called "Timely Hints." This supplements our twenty-five or so inspections per year on each farm.

"Timely Hints" broadcasts latest college test reports and many money-saving "kinks" in the handling of farm problems. Incidentally other owners have found it advisable to subscribe for themselves and their tenants. Our largest order from one man is for fifty copies. It seems to be filling a real need.

As a sample of information included in "Timely Hints," we published results of the Wisconsin "Trinity" hog feed supplement composed of two parts tankage, one part oil meal and one part alfalfa meal. Feeding of this mix in place of straight tankage as a grain supplement proved a big saving in feed costs.

Then came Prof. Evvard of Iowa State College with his wonderful "Big 10" hog feeding supplement worth over $30 per ton more than tankage, but costing no more. The combination of animal and vegetable proteins together with several minerals, which he recommended actually saved $1.10 on the cost of producing each 100 pounds of gain when this mix was fed with corn in place of the very good ration of corn, tankage and minerals. We are obtaining the "Big 10" for our men at less than the cost of tankage. The tremendous saving of feed costs on the large number of hogs which our men produce is very apparent.

Group farm management service in the buying and marketing of stock, feed, grain, seed, salt and other supplies saves the owner and the tenant much money, especially when the farm is operated on a fifty-fifty livestock lease basis. Knowing what to buy, when to buy and where to

buy are all fully as important as being able to buy at the right figure. All these factors also enter into the problem of marketing. Farm management service can be of real value in these and many other respects.

Illinois studies in farm management under the direction of Prof. Case and Prof. Moser, especially those on farms in Livingston, McLean, Tazewell and Woodford Counties are very complete and instructive. A study of their reports for 1925, 1926 and 1927 on those farms will prove a real aid to anyone in planning profitable operations. Such information we regularly summarize and pass on for the guidance of our farm operators and tenants. Of course, even then, no benefit accrues unless the ideas thus obtained are actually applied.

One of the most difficult tasks of the farm manager is to get the tenant to do the things that must be done in order to make farming pay. Farmers as a rule know how to farm better than they practice. This is evident from a study of their operations. So many things come along to upset their plans that only too often many important things are left undone. The weather, for instance, plant and animal disease and insect and other pests all interfere with prearranged plans.

We consider our farm account system one of the very valuable features of the service, made possible solely through group management. The operators and tenants make monthly reports, including all business transactions. These are audited in our Champaign office and statements rendered back to the tenants and to the land owners. Settlement between owner and tenant is thus made possible each month, and all business is kept strictly up-to-date.

Resumes and annual statements, together with inventories, crop report details, soil treatment and an analysis of the business for the year are furnished the owners. Also crop rotation plans for the coming season are indicated. This makes is possible for interested parties to know just what the property is doing. It places farming on a business basis comparable with other successful industries.

Farm bookkeeping has only too often been sadly neglected. When a practical application of accounting has been made in the handling of land, it merely means that the land owner and the tenant know where they stand and how they stand. Weak features of the business can then be detected, corrected and remedied, often transforming results from a loss to a profit.

Our finance connections and accommodations have also made it possible for a number of tenants to adequately equip themselves with machinery, power and livestock, where previously they had been seriously handicapped for lack of operating equipment and capital. This feature alone increases efficiency to a considerable extent, and even during the past few difficult years has enabled the average tenant to make money.

We recommend and employ group management supervision of individually operated farms. Personal interest is obtained in the handling of each tract of land. In so far as we have been able to learn our fifty-fifty livestock lease is the nearest duplicate of a factory piece-work basis that is employed today. On this plan, for instance, if the tenant loses a litter of pigs due to lack of attention at farrowing (some cold March night) or for any other reason, he loses half the litter. This inducement will cause him to be on the job when no cash wage will prove effective. On this plan the tenant furnishes the labor, machinery and horses. The owner furnishes the land and improvements and pays his land tax. Crops and livestock, feed and seed, whether produced, bought or sold are fifty-fifty.

A good tenant on our plan of operations by attention to details and through following modern practices advocated by us as the result of our study of agricultural college tests and reports and our study of practical experience results, can and does make excellent money. We gradually and quietly weed out those who do not follow our efficiency suggestions, replacing them with men who are only too glad to have expert guidance available, and who are willing to cooperate with us in the execution of modern farming methods.

Group management brings together a number of farms under one head, but each farm is run as a separate and independent unit. We believe, however, that larger farm units are advisable, quarter sections in place of eighties, and half sections instead of quarters. A convenient Midwest size is 240 to 300 acres, easy to rent and convenient from many angles. Improvement, investment and upkeep per acre is less than on smaller farms.

We also advocate dual or multiple ownership of large machinery, two or more neighbors jointly owning a silo-filling outfit, grain harvesting equipment, etc.

Time is money. The easiest manner in which a farmer can multiply his efforts is through the use of a larger machinery, gang plows in place of sulkies, two-row cultivators in place of one-row tools, multiple-horse hitches, more powerful tractors, etc.

A man without power machinery on the average Midwest farm today cannot hope to make money. He must do more in less time or quit. Gratifying indeed is the progress made by manufacturers along the line of filling these needs for speed, for efficiency and for the production of more per man at a cost of less per unit of crop produced.

The employment of any farm management organization with experience and training can prove an excellent investment to any land owner unless that owner can devote much time and study and attention to the handling of his or her farm property. Even then special services can be employed from time to time to good advantage. Management in any business is especially essential. Agriculture has too long neglected this important factor which, in this highly specialized age, is more and more becoming an absolute necessity.

The Future Trend of Farming in the Middle West[1]

By J. Ward Nelson[2]

MY EXPERIENCE with management or corporation farming has been of a rather specialized nature. While there are many problems in the production of canning crops that are in common with those of grain and corn farming the cost figures are comparable in few instances. I was raised on a farm in Illinois and have always been associated with some sort of farming enterprise. For eight years I have managed the farming department of our business and naturally have thought a great deal about the applicability of corporation or management farming to general farm crops. Since no special subject was assigned me I think it worth while to discuss the relative merits of farm management on a large scale and independent family systems of farming, hoping thereby to somewhat define my idea of the probable future trend of agriculture in the corn belt.

Money being generally accepted as the criterion by which an enterprise is judged, let us consider the farm income, which can properly be divided as follows:

1. Subsistence, or living
2. Operating profits
3. Appreciation of land values.

A little time can well be taken to see how these sources of income are reflected in the competence which so many farmers have accumulated before retirement age. The living they have had can be classed from poor to good. In general, those who have prospered have garnered their living largely from their gardens, orchards, poultry yards and cow pastures. These represent a relatively small percentage of the farm acreage. The living was poor or good depending upon the interest and energy expended by the family as a whole. Too often the farmer fails to appreciate the possibility of income from this source. This indifference universally leads to one or more of three evils —a poor living, an unnecessary drain upon other sources of income, or an overworked wife.

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1928.

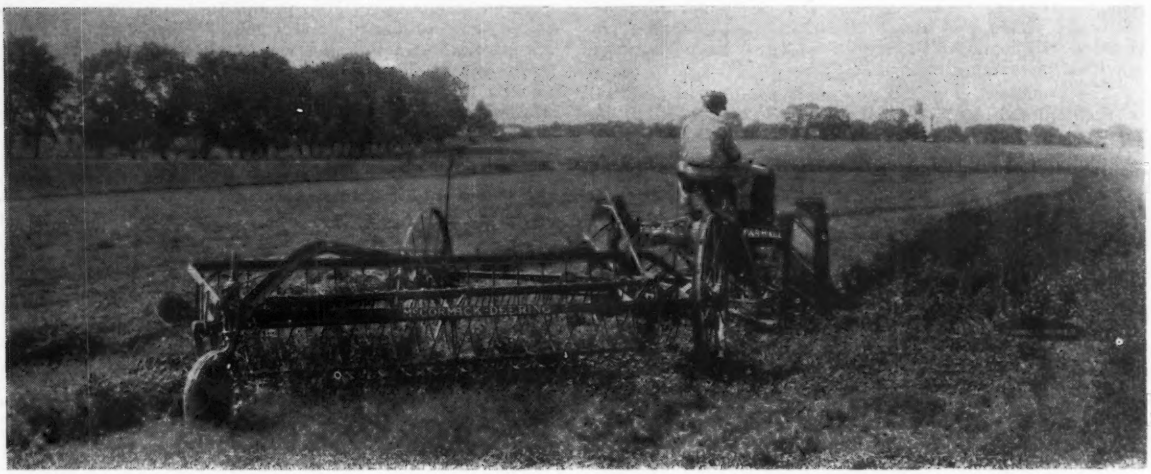
[2]Farm manager, Midwest Canning Corporation, Rochelle, Ill.

I think it can be truly said that even before the war the time some farmers seemed to regard as the golden age of agriculture there were generally very small operating profits. Most of the retired farmers of today spent a large part of their lives paying for a farm which cost them very little. I can remember distinctly the first sale of farm land in that part of the corn belt where I was raised which was consummated at $100 per acre. It was a very choice eighty and well improved.

The accumulation of wealth came largely from the appreciation of land values. In most cases the appreciation was partly earned as by clearing the land of water, stones, brush and scrub forest, and by building upon the property. The major part of the appreciation, however, came from the sources over which the farmer had no control. It is a fact that almost any honest thrifty man who contracted for a farm 50 years ago could retire with a comfortable income in 25 or 30 years, even though he displayed little managerial ability. In all fairness it must be said that while the farmer was helping to appreciate the value of the land as cited above, he was also depreciating the intrinsic value by allowing the land to become less fertile. This, in itself, indicates a change is necessary if the system is to be permanent.

Many factors contribute to the present depression in agriculture, but I am convinced that the depreciation of land values is largely responsible. During the war operating profits were higher than ever before. The farm family worked patriotically to produce more and did it. Labor shortage and the unsettled conditions of the times influenced him to buy rather than raise a large part of his living. His standard of living was raised to a very high level, in fact, many foolish expenditures were made. Machinery was purchased to enable greater production with less man power. Because of the war prices it became profitable to put marginal land under cultivation. Many farmers were caught in the scramble of land speculation. After the war there was no demand for the surplus production. Prices went down. Because of the very nature of agriculture changes in cultivated acreages cannot be

The farm plant, that is, the house and other buildings, must gradually become better adapted to the needs of the farm, if the family system of farming is to continue to exist in competition with the corporation system. Engineering intelligently applied will help the farmer to increase the efficiency of his plant



Increasing the efficiency of machinery operation requires combining as many operations as possible. This arrangement of using mower and side-delivery rake at the same time behind the tractor is a typical example

made quickly. A considerable part of the oat market was gone because of motorization both in the city and on the farm. A small part of the corn market was gone because of the Eighteenth Amendment. Inflated land values during and after the war caused unduly large interest charges. A tightening of credit prevailed generally. Many farm banks were closed, thus demoralizing the credit situation. Operating profits except for the most capable, practically ceased to exist. Only slowly did the farmer get back to reasonable efficiency in making use of his yard, orchards, and pasture for a living. His loss in inventing, as was the case in all industries, was great. Years were required to get the marginal land put under cultivation during the war back to grass or waste where it belongs, at least, at present. This tardiness together with the increased efficiency of production developed by the war resulted in continual overproduction. The most damaging effect of the post war deflation was the moral breakdown of the farm family. The continual decrease in land values was something new. The great hope of the future was gone. The goal of a competence some years ahead was obliterated. Vaguely the farmer began to sense that in the future he must depend upon an accumulation of operating profits. This was not a bright future since in the past there had been little or no such profits.

What then is the future? If we assume that the family system of farming will continue to exist, and I hope that it will, what are the changes necessary to bring it about? Certainly it cannot be done by one grand sweep of legislation. Because of the great lag in adjusting supply to demand in agriculture which will always exist, great care should be taken that in trying to better conditions, nothing is done which will tend to cause production to be increased beyond the probable demand.

The farm plant, that is, the house and other buildings, will gradually become better adapted to the needs of the farm. We will not soon see the fixed investment unduly increased by the building of unnecessarily large farm houses. How sad it is to see a mother on a farm work hard for many years to help accumulate enough to build a large house, generally accomplished at just about the time the size of her family is diminishing, and then overwork herself thereafter taking care of the unused space. Seldom is the investment recovered by the sale of the farm. A few acres near the building and the waste in the field can and will be made to produce a better living for the farm family. More attention and thought must be given to the production of vegetables, fruit, poultry, dairy products and the utilization of the waste about the farm. This will enable the farmer to put in more productive hours of labor per year. After all, this is near the heart of the problem. Those who eat must work. It is significant to note that the farm family is particularly adapted to making the most from the yards and gardens. This is increasingly true as labor and time-saving machinery is developed and more time from the crops is available. This additional time must be utilized in productive work or the family system of farming will cease to be profitable, or even exist.

The operating profits will remain small. The volume of business is small, therefore, the profits cannot be large. In grain and corn farming the farmer must be a working foreman. He cannot allow himself more than $3.00 per acre per year for management. He must take advantage of the information now available, and continually becoming available to reduce his costs and increase his yields. He must not expect too much of increased value per unit of products sold. Large and permanent enterprises are not built up that way. The farmer has been weak in analyzing his business. Few realize the limiting factor of their crop yield. He depends too much upon the weather when he should be handling his land and crops in such a way as to get a good yield in spite of the weather. Research results are continually becoming available to furnish him a basis to increase his average yield, and thereby reduce his costs per unit of crop produced. Generally speaking, he is making little or no use of this information. Without the general application of scientific principles to production the family system of agriculture is doomed. The extension department of the various experimental stations, the farm bureau organization, and the farm papers have not succeeded in getting this information applied.

It is in this connection that I think the management system of farming will perform the greatest service to agriculture and the country in general. Large-farming enterprises will continue to spring up all over the corn belt. Production costs will be lowered. This will be accomplished by increasing the production per unit of land while at the same time the costs of production are decreased per unit—one supplementing the other in greatly reducing the cost per unit of crops produced. The possibility of increasing yield cannot be questioned. Under managerial farming an accurate analysis of the situation will first be made. The crops produced will be adapted to the land; drainage perfected; proper fertilization programs formulated and carried into practice. Sensible rotation, giving among other things distribution of labor requirements, will be selected and maintained. Adequate and economical power and machinery units will be available to better work the land. I have seen a good bit of Wisconsin, Minnesota and Iowa as well as Illinois this summer.

The crops were usually good. Yet the opportunity for increased yields was apparent everywhere. These opportunities will be seen and capitalized by an increasing number of large-farming enterprises.

The reduction in production costs per unit of land will be accomplished by more economical use of power and better farm machinery. In our organization the power for 240 acres which can be taken as a fairly efficient unit, amounts to one tractor and six mules. This, I think, compares favorably with the ordinary farm, even though we are handling specialized products, the success of which largely depends upon harvesting at just a certain state of maturity, thus requiring planting and harvesting schedules to be maintained regardless of the cost. Our tractors do several times the work of the ordinary farm tractor, and our mules average 1500 hours of work per year. In straight grain and corn farming the power requirement could be reduced to considerably less than that necessary with our crops. We have some developments under way, which, if successful, will materially reduce our expenditure for power and labor. Farm machinery must be developed which is better adapted to the power available. More work must be done each time the tractor goes over the land.

Good cost accounting systems, which will be maintained by large farming enterprises, will reflect themselves in reduced costs.

This application of the science of agriculture and the profits derived thereby will be an object lesson in every community. It will do more toward getting the farmer to apply scientific principles to crop production in 20 years than has been accomplished by all other means of educational work. The farmer wants to see, not hear, not read. In this respect he is no different than others. Psychologists tell us eighty per cent of what we learn and know is through sight. The management system will always be ahead in the science of farming, but the lead will be greatly reduced.

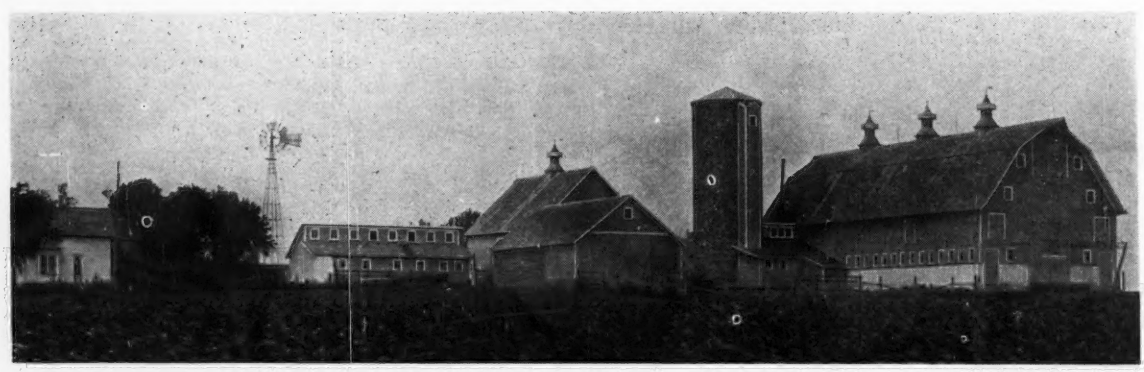
The large-farming enterprises will probably always be superior in some respects. Better management can be commanded. Machinery and power can be utilized to greater advantage. Local experimental work can be carried on and the results more intelligently interpreted and applied. Economies can be effected in both buying and selling.

There is another side to crop production too often overlooked, which I call the art of farming. This consists of doing just the right thing at the right time to each crop on each field. No doubt each of you has seen one farmer make a failure while applying rather good science to farming alongside a successful neighbor who makes no pretense of applying scientific principles, but is a real artist in handling his stock, land and crops. Unfortunately the latter is apt to scoff at his neighbor, when he should be incorporating many of the practices into his own system.

Too definitely standardized methods may mitigate against the large-farming enterprise. Power never can be used as efficiently in crop production as in the steel, machinery or automobile industries. There is always the uncontrollable factor—the weather. A certain surplus of power and machinery must be available for the emergency. If standardized technique could be applied to crop production the cost of supervision could be reduced to a small figure. Variations in the soil and weather make this impossible. For instance, we always aim to provide ourselves with power and machinery sufficient to perform certain operations that are ordinarily required with some surplus, but impress on our foreman that we are not interested so much in what work he does on a piece of land or crop but are tremendously interested in the condition of the field or crop. The artistry of farming takes its stand alongside the science of farming. The necessity of continually watching the soil and the crops makes it likely that the cost of supervision under management farming can never be reduced to a point approaching most other industries.

While it is true that many farmers of the present have not the art of farming, it is my opinion that the family system is better adapted to the fullest development of that art. The incentive for personal gain is a large factor in the success of any enterprise. In the family system the details are cared for by the man who has everything at stake. The management system should always be superior in analyzing the scientific needs and in financing and applying the remedies. The family system is better adapted to utilize the farm plant, yards, pastures and waste in the fields for their living, which, after all, is the greatest source of real income. I expect to see management farming develop rather rapidly for a number of years, then slowly give way to the family system as that system gradually incorporates real science into its program. Our President-elect, the Hon. Herbert Hoover spoke a great truth when he said, "Farming is more than an occupation—it is a mode of living."

The comparisons attempted in this paper have been made between the two extremes of agriculture—the family system and the corporation system. My experience has qualified me to discuss these. Farm management services acting between the owner and tenant are becoming quite common. In some ways, this type of organization combines the strong features of both the family and corporation systems. It is, however, better adapted to tenantry than to farms operated by the owner. It provides a medium for well-trained and capable farm managers to direct the farm practices in a general way. Under this system the personal interest of the man directly operating the farm is assured, though not to the extent of the family-owned and family-operated farm. No doubt it will lead to greater profits for both the owner and tenant. The advantage of economy of operation of power and machinery by the corporation system is in a large measure lost. The desire of ownership of our people is very strong and must be reckoned with in this connection. This type of service will continue to exist, but I do not think it will entirely replace the family-owned and family-operated farm.



Farm Organization for Modern Machinery[1]

By D. Howard Doane[2]

"I AM quite sure we are rather rapidly approaching the time when farm equipment must be sold as a part of a system rather than individual items." These are the words of J. Brownlee Davidson, and I feel indebted to him for a statement that is as prophetic as it is brief. Like all really worth while utterances, a few well-chosen words speak volumes.

A few years ago the purchase of a new, modern binder or mower, for example, meant that our new machine had perhaps better bearings, cut six inches more swath, was better balanced, or had a tongue truck, etc., etc. When the new machine was set up and operating, we found the net effect was that our teams stood up a little better, our men preferred the new to the old, and perhaps, perhaps I say—we cut an acre more of hay or grain a day.

Not long ago I had the pleasure of visiting the man considered by many in Illinois as the best farm manager in the state. He pointed out to me a field of corn saying: "That is the 250 acres of corn I raised with one man." It appeared fully up to the average of his other corn and he corroborated that impression.

It appeared that this one man had just about handled three times as much corn as his other men, with equally as good results, but in the face of all this there was a most apparent lack of enthusiasm for so revolutionary a piece of work. This perhaps seems astonishing. This manager made this statement: "Do you know, if what I have done in that corn crop is a fair sample of what can be done with regularity, I have started something that completely upsets my entire farm organization. I have thought a great deal about this thing and the facts are I cannot see just how the new can be made to fit into the old, or perhaps just at this stage completely supplant the old."

We are operating four if not five farms where tractor equipment should work efficiently. We are using it only as we did years ago for odd jobs and belt work. Why? For the identical reason I have just quoted. This brings us back to where we started.

The time has arrived for the agricultural engineer, and he must be primarily a farm management engineer, with a background of farm mechanics, or with the assistance of such a one, to step into the field of large-scale farming and make a set-up for the owner or operator, just as the industrial engineer does for the manufacturer.

As operators we are no longer primarily concerned in rated acres per day, or gallons of gas and oil per acre, bushel, or ton. We have satisfied ourselves on these points long ago. We know modern tractors will plow land and cultivate crops, and combines will cut and thresh as rated by the makers. What we do want is the assistance of a general, if you please, who can come on to our properties and create and successfully fight through a revolution. That is just exactly what we face. A one-man machine that takes the place of eight men and sixteen mules at plowing, ten men and twenty mules at cultivation, and cuts a harvest and threshing job from $5.00 to 50 cents an acre, creates nothing short of a revolution—and most of us are afraid of revolutions when we have to tackle them alone, at least without a general in charge in whom we have the utmost confidence.

Personally, I think the basic elements of success are in our modern farm machines. But to take full advantage of all their potentialities involves much more than the purchase of one, or a dozen tractors, and a combine.

"The time has come when farm equipment must be bought as a part of a system, rather than individual items," quoting Prof. Davidson again.

Now, how are we going to do it? That which follows is not the answer to that question. I wish that I might give the solution. It will not come until some of us with a broad enough background to be able to appreciate the whole field of practical farm management devote their time and attention to it as a major task.

However, I have here a set of facts and figures taken from an actual farm that attempts to show a method of approach. I have touched most of the major factors that must be considered.

Before proceeding with my figures, I wish to ask these questions for they are basic to my assumption that the owner might be interested in direct operation vs. the present practice of share rent of tenants. Has modern machinery changed the basis of relationship or crop division between landlord and tenant? Three to four years ago in Central Illinois, the tenant kept eight horses and hired one man to handle 160 acres. Today with about half modern equipment and two men and the same eight horses, he works double the acreage. Who has received the reward for this saving? Does he deserve it all? Should landlords consider a new basis, and if so what should it be? Should they equip their own land and employ farm hands? That which follows is an assumed report to the owner of a farm, now rented to tenants on the one-half share basis, to assist him in answering that question:

THE SURVEY AND PLAN

Mr. John Doe:

I hand you herewith our report on your 1280-acre farm in Central Illinois, which will answer for you the question asked of us, i.e., will it pay you to displace your tenants, purchase new modern machinery and employ a manager and laborers and operate direct?

The Farm. The general layout of your land is excellent. The two sections joining with roads on three sides and one between the two sections, makes easy access from all essential directions.

The main improvements, which will be discussed in detail later, are in the very center of the tract. This fact together with the main road running past them, makes accessibility to the fields as good as it could be. It means that it will require only a maximum of one-half mile drive to reach the farthest point of any of the four fields, for beginning work. Two miles from headquarters to a shipping and trading point satisfactorily covers this point. While the roads are not hard-surfaced, it appears that they are oiled with sufficient regularity to make possible all necessary winter travel. Of course, a hard-surfaced road to town would be counted an asset over the present situation.

Soil. The soil is the brown silt loam typical of the grain belt of Central Illinois. In our opinion it lends itself satisfactorily to tractor operation.

Drainage. It appears that you now have about seven miles of tile on the two sections. This amount is inadequate and is not even satisfactory under present methods and conditions. Much of your best land—lowest and richest—is non-productive during years of much excess moisture. In our opinion you should add at least two miles additional tile to this property, regardless of your future operating plans. The necessity for this tile is not based on extension of tractor farming. We are not assuming any additional yields due to more tile, although this would surely follow. You will find, however, that there will be seasons when you cannot work your lands in full mile rows

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1928.

[2]President, Doane Agricultural Service. Mem. A.S.A.E.

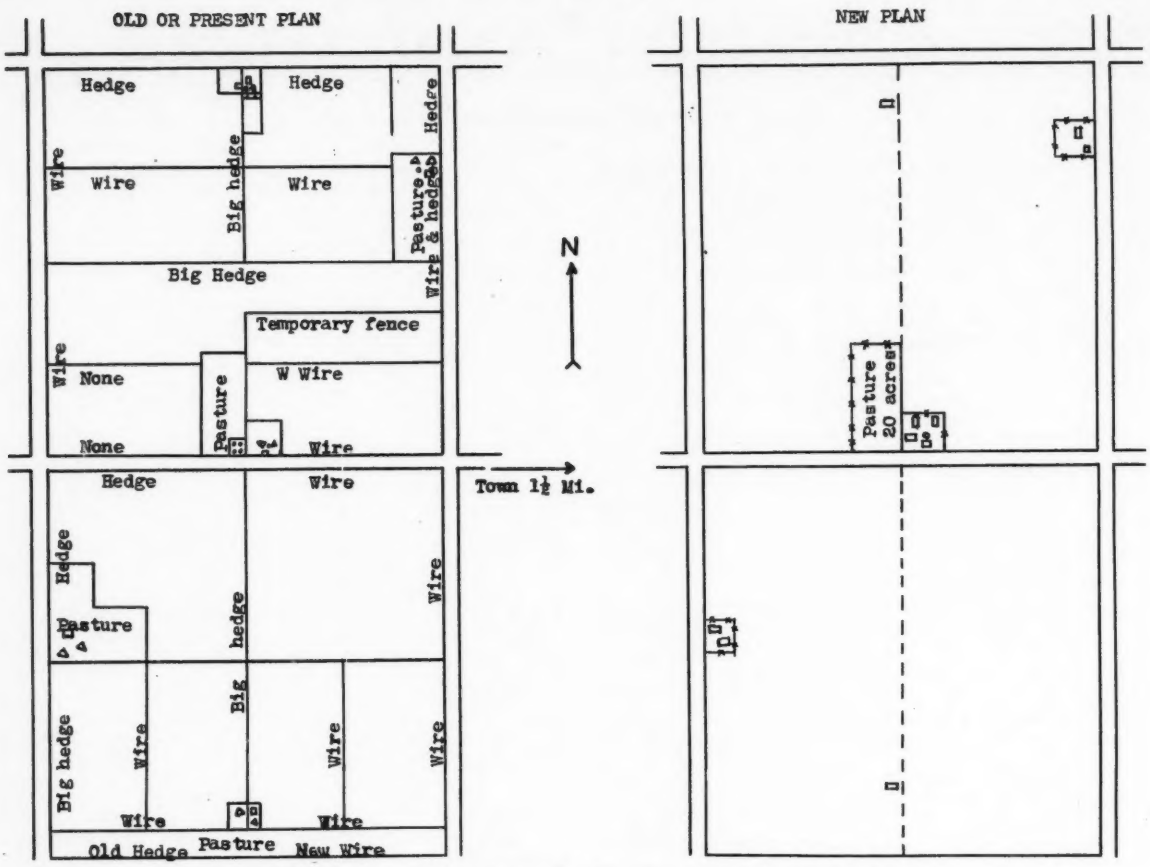


Fig. 1. Layout of the two-section farm at present and as proposed

as planned without this additional tile; this also applies now. The cost for the two miles suggested will be from $1500 to $1800. We recommend its addition.

Rainfall. The average rainfall as well as its distribution for Central Illinois, does not present any major problem. Wet falls will probably be the most serious factor affecting our proposed plan. We are depending on corn pickers for major harvesting. In the last three years they have been practically useless due to muddy fields during October and November. Our solution of this problem will be discussed later.

As an offset to prolonged unseasonable periods, we have twenty-four potential work hours per day by use of the double shift. This means that, during short periods of good weather when work has been delayed, we will be prepared to use our field equipment at night.

Topography. Your land would be described as gently rolling. None of it is so steep that soil erosion is a problem. With proper drainage installed there will be few if any ditches that cannot be crossed with all field machinery.

Each field will be one mile long and one-half mile wide. The long rows are north and south and each field will have one end that comes up to the road dividing the sections and passing the proposed headquarters. The land will work north and south more advantageously than in any other direction.

Improvements. At present there are, on the north section, three sets of improvements, one good one—except the crib which needs replacing—and two that are fair to very poor. The poor ones could be made into one fairly good set. On the south section there are two sets of buildings in fair to poor repair. The two sets could be made into one good one.

We estimate the replacement value of these five sets to be between $35,000 and $40,000. Our present appraised value is $20,000.

To put four sets in good condition, the number needed to operate the property as now being handled, will require between $5000 and $7500. This would permit abandoning one complete set.

Briefly, our plan is to abandon the north set, retain a home for one hand in the northeast set, use the central set as headquarters, abandon the southeast set and retain a home for a second farm hand in the southwest set. This will provide three homes for farm labor and with two workers in one of the houses will make available four regular hands.

We use a general figure of $1.00 per crop acre for maintenance of improvements in some sections. This is about 2 per cent of the new value. These figures may be a little high for Central Illinois, although it is only $200 a year on $10,000 worth of improvements. In this set-up we are using 2 per cent.

Insurance, fire and wind is figured at $1.00 per $100 insured value.

To bring four sets of improvements up to a livable and usable condition, will require an expenditure of $6000.00

Maintenance on $26,000, at 2 per cent annual	540.00
Insurance on above value, annual	260.00
Depreciation at 4 per cent	1040.00

For direct operation by the owner our recommendations are as follows:

1. Abandon the north set of improvements and salvage material as needed for other sets.

2. On the northeast set, abandon the barn, but retain the present almost new crib and repair the house. Estimated cost, $500.

3. On the central set maintain all buildings as they are, although the barn will not be needed, and rebuild the old crib, making it at least one-third larger. Estimated cost, $2000.

4. On the southwest set abandon upkeep on the barn; maintain the crib, repair the house. Estimated cost, $800.

5. On the southeast set abandon all but the crib. This set has a small value. Estimate cost for minimum repairs on crib, $250.

Total cost—$3550.

Maintenance on one full set and two partial sets, value at $15,000, at 2 per cent, $300.

Insurance on $15,000, $150.

Depreciation at 4 per cent, $600.

From the foregoing it will be noted that the summarized comparative figures are as follows:

	Present Plan	New Plan
Appraised value of buildings	$26,000.00	$15,000.00
Cost of new buildings and major repairs and remodelling	6,000.00	3,550.00
Operation:		
Annual maintenance on new at remodeled value at 2 per cent	540.00	300.00
Insurance at $1.00 per 100	260.00	150.00
Depreciation at 4 per cent	1,040.00	600.00
Total annual cost	$ 1,840.00	$ 1,050.00

The new plan almost cuts the repair and remodelling cost in half and saves $800 a year on annual upkeep, insurance and depreciation.

Fences. By referring to our map of the farm, as it is now, it will be noted that there are about 14 miles of fence on the two sections. Almost half of it is a large hedge.

We find it difficult to determine what your annual fence cost has been. You have furnished new fence from time to time and tenants have also made purchases. You have paid for hedge removal and tenants have done practically all hedge trimming.

Our recommendation is that all fences, except around barn and house lots and one pasture, be removed. This can be done as off-season work, and we estimate that saving on maintenance and new fence purchase and salvage of hedge posts for sale will in at least three years pay for removal costs.

The fourteen miles of fence occupy about 42 acres of land, that can with the new plan be put into crops. On the basis of the present average crop acre income of $12.11, this will make an additional annual income of $508.62.

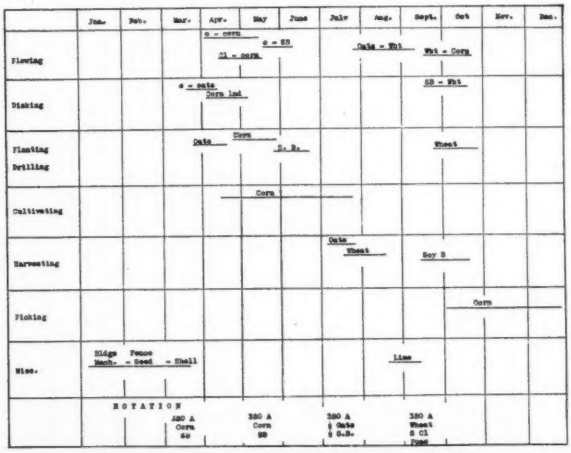


Fig. 2. Proposed yearly field work schedule

(Yields on old fence rows are generally much above the average.)

Present Situation. To obtain a basis for comparing the proposed plan with the present, we have taken actual acreages and yields for the average of the last three years, which are as follows:

Crop	Acres	Bushels produced per year	Highest per acre	Lowest per acre	Average per acre
Corn	615	26318	46	38	43
Oats	415	11230	31	21	25
Other crops[3]	30	270			9
Pasture	120				
Lots, fence rows, etc.	70				
	1280				

Yields, Value, Income. We found it difficult to obtain an average of the prices secured for crops because the practice of holding from a few months to as much as a year has been followed. We have assumed a fair f.o.b. car price that is as near to actual as we could determine:

Crop	Owner's share	Price	Value
Corn	13159 bu.	$ .75	$9869.15
Oats	5615 bu.	.35	1965.25
Other crops[3]	135 bu.	1.25	168.75
Pasture		10.00	1200.00
Total			$13203.15
Average per total acre			$10.30
Average per crop acre			$12.11

This shows an average gross income of a little over $13,000 per year to you, the owner. From this you have been paying taxes, insurance, interest on investment and management. In our set-up, taxes and interest will remain the same, so we are not using it in the comparison. Insurance has been figured and management will be referred to later.

The tenants' share of the above has been the same less pasture rent. This means that the direct cost of production to the owner has been almost exactly $12,000 a year, or, in round figures, $10 per income acre.

THE NEW PLAN

The first thing to be made clear is that this is not a profit and loss statement.

The plan we propose is as follows:

Buildings. Maintain one central headquarters at the center of the farm, and two houses for year-round hands. Their homes are not located as conveniently as they should be, but will be usable.

All good cribs will be maintained and the one at headquarters rebuilt.

The outlying barns, for the most part in very poor repair, will be abandoned or, where usable, retained for storage. The main barn will be used as shop headquarters and for horses if used.

Fields, Fences, and Lots. Make farm fields of 320 acres each, one mil nort hand south and one-half mile wide. Each field will have one end fronting the main service road.

Remove all fences, except for pasture of twenty acres and lots around three houses of ten acres.

Crops. Use a four-year rotation of corn, corn, half oats—half soybeans, wheat. Soybeans can be checked with the corn. Sweet clover in part or all of the wheat, or pass may follow to be plowed under. The details of field work required, and its distribution is shown on the appended table (Fig. 2). It might be added that it calls for land preparation during every month from spring opening in March to late fall, October.

Harvest starts in early summer with oats, near laying by time of corn, an dcontinues to full winter with corn

[3]Other crops have been soybeans, wheat, barley, clover, etc. As soybeans have dominated, calculations are on a basis of this crop.

picking. We have laid particular emphasis on labor distribution, with as broad an opportunity as possible for alternates, as more or less wheat, soybeans, oats, sweet clover, etc. We have also followed the common practice of half the land in corn, and if desired from every acre a grain crop may be harvested.

On the other hand, livestock can be worked into the plan in a major degree. Of course corn, oats, soybeans and clover and pea hay are available for full feeding.

To make our set-up clear and strictly comparable, we will keep it on a straight grain basis and figure crop residues as a gain or maintenance to fertility. Lime will be required on the wheat and clover fields.

Equipment. At this point we come to what many will consider the crux of the whole plan. Our figures have been suggested and verified by men from one of our large farm equipment companies. Frankly, the number of tractors seems one short so we have added a contingent set-up to cover an additional tractor and equipment or six head of horses and equipment. Prices are retail, list appended. The major equipment, without giving details, is as follows:

One 15-30 tractor with plows, disks, harrows, wheatland plow, corn picker, and combine	$3643.00
Two 10-20 cultivator type tractors, with plows, disks, harrows, soil packers, rotary hoes, four-row cultivators and four-row planters	3600.00
Two one-ton (one special farm type) trucks	2000.00
Miscellaneous equipment, only one each, as mower, rakes, drills, etc.	757.00
	$10,000.00
Reserve equipment purchased as experience indicates (equivalent to one cultivator tractor and equipment or six horses and equipment)	$1600.00

It might be noted that this total of a little over $10,000 is $2000 less than the present appraised value of the present equipment owned by the tenants. This appraisal is not more than one-half its new replacement value.

OPERATION

We propose the employment of three full-time men, who will be furnished homes, garden spots, and pasture and roughage for a cow. We will pay them $65 per month, and one working superintendent $100 per month. Annual labor, except extra $3540.00

We estimate that one two-row picker will in thirty days' field work pick 450 acres, leaving 190 acres to be picked outside. With average yields, and teams at $3 per days, and shocking at 6 cents, it will cost $490 for pickers, and $270 for teams. Total 760.00

Harvest labor will be exchanged to balance that needed.

Total labor			$4300.00
We estimate the following days' work and fuel for tractors:			
One 15-30, 100 to 110 days at $3.00	$330.00		
Two 10-20, 80 to 100 days at 2.50	500.00	850.00	
Overhead at $300 per year for 15-30	300.00		
Overhead at 225 per year for 10-20	450.00	750.00	1600.00
Operation of reserve equipment			500.00
Two 1-ton trucks at 300 miles per month, each at 10 cents—$60 per month			720.00
Lime, fertilizer and seed			2000.00
Contingencies:			330.00

SUMMARY

Capital Costs

	Present Plan	New Plan
Remodelling buildings	$6000.00	$ 3550.00
Tiling	1750.00	1750.00
Tractors, equipment and trucks		10000.00
Reserve equipment		1600.00
Total	$7750.00	$16,900.00
Operation		
Labor		4300.00
Three tractors, fuel, overhead, etc.		1600.00
Two trucks		720.00
Reserve equipment operation		500.00
Seed, lime, etc.		2000.00
Contingencies		330.00
Depreciation, maintenance and insurance on buildings	1840.00	1050.00
Paid tenants for crop production	12000.00	
	$13,840.00	$10,500.00
Difference in cost in favor of new plan		$3,340.00

These figures indicate that the new plan calls for about $10,000 more capital outlay than the old plan providing in each case that the land is properly tiled and buildings put in shape.

In operation costs we find a difference in favor of the new plan of a little over $3000 a year. This figure takes into consideration total cost of production from the owner's standpoint. That is, it includes what he pays tenants for producing the indicated crops. We have not included interest on additional expenditures for tile and buildings, the net effect of which is in favor of the old plan. We have considered interest charges against tractors in tractor operation costs.

INCOME

The new field arrangement with elimination of fences and pastures, which also includes the effect of the revised cropping plans, makes the following set-up:

Corn	625 acres at 43 bu. at	$0.75	$20,156.25
Oats	156 acres at 25 bu. at	0.35	1,365.00
Soybeans	156 acres at 9 bu. at	1.25	1,755.00
Wheat	313 acres at 20 bu. at	1.25	7,825.00
			$31,101.25

This income of a little over $31,000 is an increase in total gross income over the present plan of $5901.00.

Bringing the two figures together, we then have this:

1. Present plan pays the owner, in terms of crops and pasture rent, $13,203.00, from which he pays maintenance and insurance of $1840.00, leaving $11,363.00, with which to pay taxes, interest and profits.
2. The new plan brings a gross income of $31,101.00, from which there is deducted a gross operating cost of $10,500.00, leaving $20,601.00, from which to pay taxes, interest and profits, these items being the same in both cases.

The difference between the two plans in operation and organization is $9,238.00 per year in favor of the new, with a big opportunity to increase this margin, while the old plan is much less flexible.

CONCLUSIONS

The idea of exclusive power farming is in a sense new, although not wholly untried. On farms where efficiently installed, results have been satisfactory, although there are many instances of failure.

In your case we feel that you have these facts in your favor:

1. An adaptable soil
2. Medium, well-distributed rainfall on the average
3. Good drainage, with excellent drainage obtainable at low cost
4. Large, regular fields
5. Standard crops easily diversified
6. Labor well distributed
7. Well-located buildings for headquarters
8. Close to shipping points
9. Fair to good roads
10. Men available who are familiar with tractor operation.

Large-Scale Farming Problems Discussed

FOLLOWING the presentation of the scheduled papers at the session devoted to large-scale farming, which was a feature of the meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 4 and 5, the meeting was thrown open to general discussion. The important contributions to this discussion follow:

WHEELER McMILLEN[1]: In the papers on large-scale farming, to which we have listened, you have no doubt noticed great unanimity upon one point at least; that is, the desirability, whatever else happens in agriculture, of finding a type of organization that will maintain the high standard of rural living we would like to see. There are men here who are advocates of the family type of farming, the supervised type of farming, the corporation type of farming; but whatever form they advocate, they have that one outstanding objective in mind.

If we are going to have corporate farms or supervised farms, we shall likely go outside of agriculture to get the capital. Within the week a man, not myself, interested in raising capital for a large agricultural enterprise of the corporate type, approached a nationally known multi-millionaire known to be greatly interested in agriculture, and who has acquired his own success in business with the corporate type of organization, who declined any financial aid, although he believed corporate farming would succeed. He declined to offer his assistance in financing it because he feared its social effects.

That is perhaps a forcible illustration of the need that is developing in these new type of farming. We must plan to preserve and enhance the initiative and the opportunity that prevails in our present type of organization.

The corporation has been an amazing factor in the development of the industrial prosperity of America. It has come along not merely because it provides for limitation of liability, but because it brings concentration of capital, one thing we need in agriculture. It makes possible the diffusion of managerial ability, which we need in agriculture, because it provides an opportunity for men who might not, within their own resources, have the ability and capital to be able to create opportunities for themselves.

Whether we develop agriculture in some sections along these new lines or not, we do need capital, we do need managerial ability, we do need to create more opportunity in the industry for the young fellows coming along—in whatever type of agriculture that prevails, in whatever area, and in whatever commodity. The type that is economic will be the most successful. Whatever we feel, whatever we believe about family farming, supervised farming, corporation farming, will matter little. The thing that determines the trend of agriculture is income, because it is only by greater farm income that we can support the present standards of living and continue to raise the level of rural civilization.

J. BROWNLEE DAVIDSON[2]: I suppose if we have any justification for wanting large-scale farming it is, first, because large-scale farming offers promise of greater efficiency, or perhaps greater economy, because efficiency in the end reveals itself in greater economy. And in the second place, we might want large-scale farming because it might contribute to the well-being of those engaged in the industry of agriculture.

How do we expect to introduce greater efficiency or greater economy by large-unit or large-scale farming? There are three advantages suggested, and I think all of these have been mentioned sometime during the day. The first is that large-scale farming would provide a higher type of management, a higher degree of management. The second is that large-scale farming would offer an opportunity for the use of specialists. And, in the third place, large-scale farming would provide an opportunity for the more efficient use of equipment.

Dr. Nourse[3] discussed the relative opportunity for advancement in the economic phases of agriculture as represented by cooperative and marketing, and the productive phases of agriculture. From the viewpoint of the engineer, it will appear that advances in economy of production seems to be a particularly inviting field. Average efficiency in the use of power and labor is now much below best practice and the cost of power and labor make up a large part of the cost of production—40 to 80 per cent of the total and more directly under the control of the farmer than many other of the important items of cost.

I believe, as Prof. Wilson, does, that large-scale farming cannot possibly advance rapidly because we do not have the men who can manage it. Industry has provided a long term plan for the training of men for executive work. Last year at our institution thirty-two industries sent scouts to look over the engineering graduates. They take those men and start them out with a minor job and small salary. After the next fifteen or twenty years—if

[1]Associate editor, "Farm and Fireside."

[2]Professor of agricultural engineering head of the department, Iowa State College. Charter A.S.A.E.

[3]Chief, agricultural division, Institute of Economics.

Engineering is only one of several factors, including financing and management, influencing the scale of farming operations. The most practicable scale for any particular enterprise will be a compromise between the ideals of the several factors

they have progressed in the industry—they will be able to take on a managerial position. Some men never advance beyond the first stage. Our best industries are taking the best red-blooded men the country is producng and are itraining them for these positions.

Now you may say that large-scale farming has not succeeded in the past. Is this a real argument? Let me remind you that in the seventies there were two hundred and thirty manufacturers of harvesting machinery. In 1904 there were only about a dozen. That is about the same sort of proportion you may expect. In my judgment we have not the men to be successful managers and we have the system for training them. Prof. Wilson in calling attention to this situation has put his finger on one of the great problems. We have a great many men who think they could manage large-scale farming. Industrial farming is a production business; it is producing agricultural products.

Now let us discuss for a minute the relation of large-scale farming to the general welfare of the farmer. Just a few weeks ago one of the agricultural leaders of the countr yaddressed one of the larger agricultural organizations and laid down a program of some thirteen or more points for the development of American agriculture. The second point he made was that a special effort should be made to prevent the development of large-scale or, as he said, corporate farming. It should be pointed out to this man, that a lower standard of living exists in agriculture than in any other vocation of our entire country. It should be pointed out to him that the lowest wage scale exists i nagriculture—lower than in any other industry. In certain parts of the United tSates the time of a mule on the farm is worth more per day than a man. Now does our agricultural leader want to continue that or does he want to change it? I take it that if he is honest in his contention, then he would like to continue and cultivate the situation where a mule is worth more than a man.

It is all right to have ideals and to build air castles. We are not thinking of the large farm with the bunk house farmer and all that goes with it. But let us think, perhaps, of a farm! comprising a model community large enough to support a man of managerial ability,—a $10,000 or $15,000 a year man. The management will introduce the recognized principles of industrial efficiency. The best possible social conditions will be provided for the workers in this comm—unity. There will be good schools, and there will be community spirit. This is a type of farming we want. It will do away with the slums in agriculture if you please.

The large-scale farm to be a success must provide for efficiency rewards. The men will have an interest in the organization for they will either share the profits or be stimulated by some means for giving an efficiency reward.

F. E. FULLER[4]: While large-scale farming may come to the corn belt, there is a distinct trend at the present time for the small units to avail themselves of supervision by those who are competent and trained for the work. "Group management" is the correct term. The cost of skilled management per farm is reduced largely by the number of farms which a man can care for with modern means of transportation and good roads. In central Illinois a dozen different men have started in business in the last two years. There is no uniformity of set-up. Generally some large holding of land is the foundation for such undertaking. Where there is some uniformity of enterprise, charges for such service has been on the acre basis. There is no satisfactory means of determining what such charge should be. On livestock farms where the tenant is a limited partner with the landowner, a greater amount of service is rendered than on the grain farm.

The actual work of a farm manager seems to be that of a landowner who would have time to do for the tenant what should be done if he knew what should be done. In other words, many land owners now recognize that good

[4]Proprietor, Fuller Agricultural Service.

The farm truck is one piece of equipment which is making it possible to farm more acres per man

farm management requires special training and that it must be followed up as any other profession. He realizes that to give the farm proper supervision would take too much time away from his own business. The economy in traveling from farm to farm in the same neighborhood might not be possible for the single farm owner. This is facilitated with the present management methods.

General farm management is the greatest problem and the greatest single factor within that problem is that of the agricultural engineer. Hardly a day passes but there is a demand for information which it is an engineer's job to get and make available.

The most difficult qualification for any farm manager to fill is that of a diplomat. The ability to get along with people is necessary. The tenant farmer in the corn belt is one who still claims considerable independence and to get the best work from him requires an understanding of farm folks.

Whether the farm manager is showing the tenant the latest discovered corn rot diseases or attempting to eliminate swine disease troubles, or draw up a fair basis for a lease, there is a constantly changing task. Frequent farm visits put the tenant up on his toes. Better farms for the worthy are kept in mind.

These usual problems of production which most present day farm managers in the central part of Illinois face do not overcome the handicaps of small unit operation. However, we are combining farms to bring the fruits of efficiency that are obtainable on large farms. The public and the landowners have resented the idea of corporation farming. However, that will quickly be overcome when such operations prove profitable. Such prejudice sometimes comes from the small merchant who sees his trade vanish because large units can buy more economically.

JOHN S. BIRD[5]: Seven years ago the Kansas Agricultural Experiment Station completed a series of experi-

[5]President, Wheat Farming Company. Mem. A.S.A.E.

ments on the relation of early preparation of land to the nitrate content at seeding time, and to the resulting yield of wheat. The conclusions were very striking. I read the bulletin soon after its publication, and the next year I went to one of the men farming some land I own and told him I would be glad to pay for the oil and gasoline for farming this quarter of land if he would agree to condition; that was that he have it all plowed by August 1. He finally did the plowing.

The next year when it came to settling up for the wheat rental on that land, he gave me as a fourth share a check for $996.00 And he said, "You gave me the most important lesson in wheat farming I ever had."

The fact that the information the Department of Agriculture is putting out is being made use of so slowly, gave us the idea there ought to be a big thing in the farming industry for the man who has the money to invest. And in the last five years we have been growing wheat on a large scale successfully.

This year we initiated the idea of corporate farming, selling stock in our organization to get more capital with which to operate on a larger scale. It is too early to say much with regard to that except that securing capital is a big problem, but the field for large profit is most promising.

Prof. Davidson said there isn't much danger of corporate farming disturbing the farming business in general, because there were not enough men who were experts in that line, and with thi[illegible] agree. On the other hand, I believe, as was pointed out by Prof. Wilson, that there is going to be great development in corporate farming. The area of the wheat belt, known as the great plains region, is exceedingly fertile. It is an open gold mine, of which the real possibilities have scarcely been scratched. We in Kansas have been doing some of the pioneering in corporate farming, and I may say it is hard work but we have been very successful thus far.

One of the speakers touched on one of the most important things in connection with the production of crops, which is true of the whole great plains region, and that is having equipment and power in reserve sufficient to do the work quickly and do it at the right time. The plowing of a section of land at the right time may mean the difference between a loss and a positive gain. There is no question but what timely preparation and timely cultivation and being prepared to do the work at the right time is the biggest thing in the production of wheat in the great plains region.

CARL WILLIAMS[6]: My impression is that the mills of the gods grind surely although slowly. Whatever is to come in the way of corporation farming will come as a matter of the competitive deevlopment of agriculture and not because anybody talks either for or against the idea.

Farming in the Southwest is developing in three directions: (1) Individuals are learning to operate more land with larger tools and units of power. This is the result of individual farmer intelligence. (2) We have the corn-belt type of manager operation in which the manager directs the work of share croppers or third-and-fourth renters. (3) We also have the corporation farm which with us is largely land which has been taken over by the insurance companies and the farm mortgage companies and that in many cases cannot be sold for what has been put into it in the way of mortgages.

These corporation farms are being operated on a strictly mechanical basis, and they run all the way from 1,000 to 2,000 acres in size. They are operated by hired labor and supervised by efficient managers.

Which one of these types of farming will survive, I do not know. I am sure that the one that does survive will do so because it proves eventually to be more efficient than the others and to result in greater prosperity for owners, operators and workers. In the end, neither society, education nor the state are going to suffer as a result of increased agricultural prosperity no matter by what method it comes.

J. G. OHSOL[7]: Our corporation is a shipper of agricultural machinery to Russia and I am interested in this discussion for our clients' sake. The first question I have is with regard to repairs. In the corporation type of farming, or in the family type of farming with a manager, do they run their own repair shops or do they have their tractors overhauled and all the other large repairs done at the town garage or at a garage maintained by the implement people in that territory near by where a large supply of spare parts is on hand?

My second question pertains to custom work. That problem was also mentioned. Trucking, plowing, combining is done either by the farmer or manager himself with the proper equipment, or else it is done by custom work. It would be interesting to know whether the custom trucking, custom combining, or custom plowing is more economical on a large-scale farm, especially in corporate farms, or is it more economical for the farmer to have all this equipment on hand, whether he runs his trucks one or two months a year or whether he can use them 11 or 12 months out of the year?

My third question pertains to diversification, which was also very briefly touched upon. I want to know from an experienced manager whether it is possible to run these large grain farms, say, in Montana, for ten or fifteen years, as pure grain farms, with one crop following right after the other, without introducing any crop rotation whatever. Is this simply a pioneering method of sapping the virgin soil in the central states and will the later generations have to build up the soil, or will the soil maintain its fertility?

J. WARD NELSON[8]: As to repair work, the repair work on our machinery is handled by a service which maintains a shop in town. Of course, we maintain service men in the field during the operating season to make temporary repairs as they are needed. But the machinery is overhauled completely in the centralized shop. I think it works very successfully and it is cheaper than trying to do this work on the farm.

With regard to the trucks, we have used trucks owned by ourselves; we own a good many now. Also we hire some custom trucks. I think on the whole custom trucking is cheaper than owning our own trucks.

D. HOWARD DOANE[9]: Answering Mr. Ohsol's first question; on our larger properties we generally establish and maintain our shops for the maintenance and repair of the equipment. Generally one of these units is in charge of a man who has had more or less shop experience. We set up in our budget a definite amount for the maintenance of our machines and equipment. We can handle perhaps 95 per cent of our repair work in our own shops. The major repair parts, of course, have to be bought.

As to the second question, we do very little custom work for the simple reason that we cannot get it. We avail ourselves of it whenever we can get it if it does not seriously interfere with our other work at that time.

Answering the third question as to fertility, I can take you to a plantation in the South, not one of ours, that has produced its hundredth consecutive cotton crop and is now producing equally as well as it did in the beginning.

In our work we try to diversify and are using rotations sucessfully. In fact, we find diversification is generally advisable.

QUESTION: I would like to know how Mr. Campbell is going to maintain the fertility of his land?

M. L. WILSON[10]: I do not think Mr. Campbell, like the other wheat farmers in the West, is paying very much attention to that problem. In the first place, they do not get increased yields by using sweet clover. The western

[6]Editor, "Oklahoma Farmer-Stockman." Aff. A.S.A.E.

[7]Vice-president, Amtorg Trading Corporation.

[8]Farm manager, Midwest Canning Corporation.

[9]President, Doane Agricultural Service. Mem. A.S.A.E.

[10]Professor of agricultural economics, and head of the department, University of Montana.

soil is extremely high in nitrogen, and I believe the prevailing opinion is that this problem about fertility is something that need not be worried about until the nitrogen goes down to some point where we can get increased yields by growing sweet clover or something of that kind. The question can be asked, why would it be necessary for the farmer on that kind of land to practice conservation with regard to the nitrogen for future generations when we are not practicing it with regard to other natural resources when society seems to need them?

I think the agronomists in Montana feel that the problem of nitrogen on a good many of those soils will probably turn up in 20 to 25 years, and they have the feeling that, when it does, they can probably use sweet clover—or who knows but that our technology will be advanced to the point where we can extract nitrogen from the air? At any rate, they are not worrying very much about it.

MR. BIRD: In the matter of fertility, the Kansas Agricultural Experiment Station has continually grown a crop of wheat on one acre for 19 years by what they call the listing method, and the yields they have had during the last five-year period are higher than the yields they got in the beginning. With us the nitrate proposition is just exactly as Prof. Wilson has indicated. At the Kansas station the top three feet of the soil referred to, plowed reasonably deep in the middle of July, had at seeding time, on October 1, 113 pounds of available nitrate per acre. The land plowed on September 15 had 43 pounds of available nitrate per acre. And the land which was not plowed, but which was disked preceding drilling on the first day it was drilled, had 25.8 pounds of available nitrate per acre. So with us the time of the preparation of the soil answers the question with regard to nitrate.

That would apply to the western two-thirds of the state, and, of course, it would apply also to Nebraska. The experiment stations tell us the land will probably not need any fertilizers until the next generation. The eastern one-third of Kansas may need lime or fertilizers within 25 years. The only element we are likely to be short of is phosphorous, and there is a very large supply of phosphorous in our soil. But so far as nitrates are concerned, I think there will never be a question about that.

QUESTION: I would like to ask Mr. Wilson how they figure they can conserve the soil fertility? They can do it as far as the chemical constituents are concerned, but what of the wind and water?

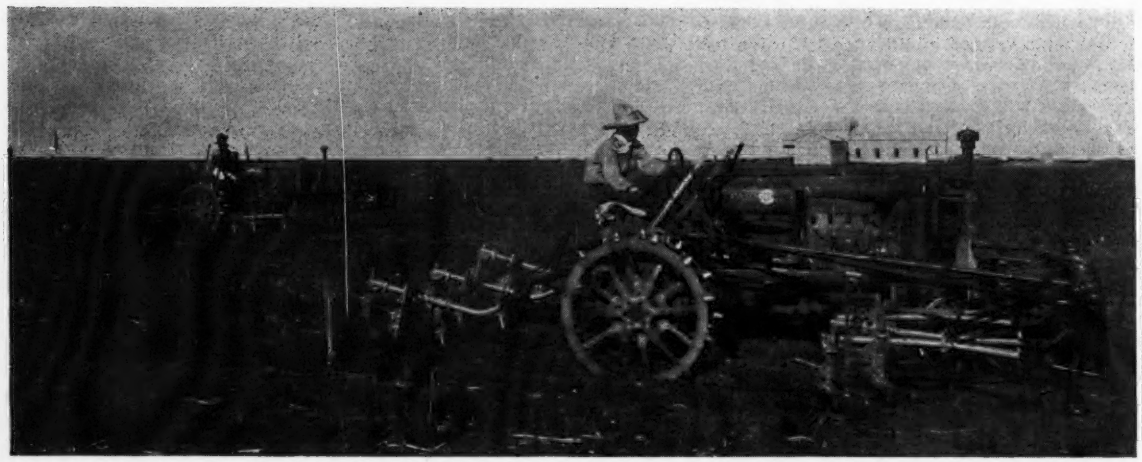
MR. WILSON: Water isn't a very big factor in most of Montana. As far as the soil blowing away is concerned, it might be a big factor in the case of a 40-bushel yield, but I don't think it is serious. There are two kinds of soil blowing. One kind we can't stop. In the sandy type of soil that naturally takes care of itself and people don't farm it so much. In the other kind of soil blowing, our agronomists have developed three systems of control that are working very well.

The first system is an idea we borrowed from Kansas. We call it corn fallowing. The idea is to plant corn on the land you are going to summer fallow. But instead of planting the corn as you would plant it ordinarily, with each of the rows being 3½ feet wide, you plant two rows and then skip two rows. That gives you a space 3½ feet between two rows of corn, or a fallowing space of 10½ feet, and then two more rows of corn.

With this system of corn fallowing, we think we can raise two rows of corn and leave two rows blank without any more hours of man labor than would be necessary if we summer fallowed straight through. The two rows of corn act as a barrier; they hold the snow and wind.

The second thing is the use of the one-way disk plow. And the third thing is not to plow. Summer fallowing is one thing which has considerably reduced the labor hours per acre. After the land has been worked up once it will probably be fallowed four times before plowing again. They go over it first with the disk. Our people seem to think up to date that land fallowed will hold as much moisture, and the protein in the wheat produced will be just as high, as it would be on land which was plowed.

MR. BIRD: (Mr. Chairman, I arise to a privileged question). There is no desire to take unnecessary time but inasmuch as the gentleman has questioned our cropping practices related to soil and also has raised the question of wind erosion, I feel that it wouldn't be fair to leave these matters unanswered. In the first place, we all understand that no system of agriculture can go on and on robbing the soil, and we have no thought of doing it. The points involved in that were answered so far as calcium, phosphorous, potassium and nitrats are concerned when I spoke a moment ago, and in the matter of wind erosion, I will say that a few years ago that was considered a serious matter, but it has been solved. Personally I bought some of the worst wind-blown lands of Kansas in the belief that it could be mastered and it was. A quarter section of such land which was one of the worst was brought back to productio nin one year, and the second year this particular quarter of land yielded a larger number of bushels than it ever had before—more than 35 bushels per acre. We of course expect to observe a system of crop rotation which will include a fallow, and we also expect to return the larger part of the straw and green growth to the land. When the organic matter is thus restored to the soil, it has been the experience of the government stations of the plains region, that the fertility will be maintained at a high standard almost indefinitely. I can only refer you gentlemen to the actual records which have been produced on carefully conducted experiments of a period of more than 25 years.



A Field Test of Tractor Wear and Endurance[1]

By A. H. Hoffman[2] and E. J. Stirniman[3]

IN THE test reported here the Caterpillar Tractor Company of San Leandro, Calif., and the Agricultural Engineering Division, Branch of the College of Agriculture, University of California at Davis, cooperated. The former furnished the tractor and secured through the California Packing Corporation the necessary fields, implements, fuel, oil, and labor; the latter furnished men to supervise the field work and to take performance data (E. J. Stirniman and C. E. Barbee), and to weigh and measure certain wearing parts of the engine before and after the test (C. E. Barbee and A. H. Hoffman).

The "Caterpillar" Twenty used in the test was loaned to the University for class instruction purposes through the manufacturer's Sacramento agent on February 2, 1928. It had been used for student practice driving and for demonstration purposes without load a total of about 20 hours before the test. During the last week of August, 1928, it was fitted with instruments to record time of use, total revolutions of the engine crankshaft, total distance traveled, per cent of track slippage and drawbar pull. Also at this time, the pistons were taken out and these together with the rings and other wearing parts carefully measured and in some cases weighed an analytical balances. After the engine was reassembled the tractor was hauled by truck from University Farm at Davis, to the Hastings Ranch of the California Packing Corporation near Rio Vista and at noon on September 1 it was started on a 408-hour non-stop run.

The work done was disking and floating land from which a crop of sugar beets had just been removed. The ground was very cloddy in places, some clods being so large that they scraped on the bottom of the crankcase the first time over. A float loaded with sacks of earth and a spike-tooth harrow were used to increase the load after the ground had been gone over once.

During the 408 hours of the test the engine ran without a stop, the crankshaft making 28,989,513 revolutions. The tractor chassis ran a total of 384 hours 58 minutes, all in second gear. Of the remaining 23 hours 2 minutes, 17 hours 41 minutes were used in servicing the tractor and disk harrow, 2 hours 6 minutes in making tractor adjustments, 1 hour 12 minutes in replacing bolts in the disk harrow, 1 hour 2 minutes for reading of testing instruments, and 1 hour 11 minutes in adjusting the load, taking photographic records, etc.

The tractor travelled 1329.97 miles covering an equivalent area of approximately 1290 acres once over. It used 1143.5 gallons of gasoline, 108½ quarts of oil, (77½ quarts of oil were drained out and 11 quarts estimated as lost by leakage), and 24.6 pounds of grease. During the first 10 days the drawbar effort was 10 to 11 hp. During the remainder of the test it was approximately 18 hp.

Temperatures of the air, oil in the crankcase, radiator water, air cleaner oil, and the transmission and final drive lubricant were taken at intervals. The maximum temperature recorded of the water in the radiator was 201 degrees Fahrenheit. The temperature reached the 200-degree mark twice, due to a blanket of weeds covering the front of the radiator. The weeds were cleaned off the thirteenth day and again after the test was completed. Boiling was not reported or observed during the test. The minimum temperature of the water in the radiator recorded was 143 degrees. The air temperature at the time was 62 degrees. The lowest air temperature observed was 49 degrees, at which time the radiator water was 144 degrees. The transmission lubricant had a somewhat gradual increase in temperature, reaching a maximum of 165 degrees at the close of the test. The left final drive ran 10 to 20 degrees warmer than the right. The maximum observed temperature of the final drive was 161 degrees. The difference was not due to excess turning in one direction, since successive turns were made in opposite directions. Approximately 7720—180-degree turns were made during the test. The large number of turns made was due to the small size of the separate plots.

The chassis of the tractor did not require any repairs or adjustments during the test. A leaf of the equalizer spring was broken the thirteenth day of the test. It was not repaired since it did not interfere with the tractor's operation.

The engine did not need any adjustments or repairs that required stopping. The following troubles developed and were corrected with the engine running: A water leak past the pump shaft corrected by tightening packing nuts; an oil drip from oil filter case, bolts tightened; a leak from gasoline tank, new tank substituted; engine valves not closing properly (after 300 hours run), tappet clearance adjusted. If the run had not been continuous

[1]The full report, of which this is a brief resume, is on file and may be inspected at the office of the Agricultural Engineering Division, University Farm, Davis, Calif., or at the office of the director of the agricultural experiment station, University of California, at Berkeley. This is the first official release by the University on the non-stop tractor test at Rio Vista.

[2]Research specialist in agricultural engineering, University of California. Mem. A.S.A.E.

[3]Associate professor of agricultural engineering, University of California. Assoc. Mem. A.S.A.E.

Fig. 1. (Left) The "Caterpillar" twenty was serviced completely just before the start of the test at noon, September 1, 1928. Fig. 2. (Right) The test under way. The field was rough and dusty. Acrop of sugar beets had just been harvested

and the engine allowed to stop and get cold, it would have been necessary to adjust the gaps in the spark plugs before the test was over. After the test it was found that they had widened to about ⅛ inch. Besides the things just mentioned only a few other minor matters needed attention, the principal of which were cleaning off leaves and trash from the radiator and from the filter of the air cleaner and cleaning out of the crankcase oil filter. Aside from these things that needed attention during or at the close of the test (all of them minor and capable of being handled without stopping the engine) there was nothing to prevent the continuance of the non-stop run. While the valves were not particularly in need of being ground, they were ground in while the engine was disassembled after the close of the test.

No attempt was made to make this a test of any particular kinds or brands of gasoline, lubricating oil or gear grease. All that was required in this regard by the University was that no change be made during the tests. The materials used were secured by the California Packing Corporation. The fuel used was "Union Ethyl" gasoline having a specific gravity of 0.76 at 78 degrees Fahrenheit. The oil was "Aristo Extra Heavy." The greases used were all "D A"; for transmission, "No. 1," for final drives, "No. 2" and for track rollers, etc., "No. 3." The disk was a Killifer, also secured by the California Packing Corporation.

After the official stop of the test the engine was again started before any adjustments or changes of any kind had been made upon it and a test made with the following results: Maximum horsepower, 21.09; maximum pull, 3000 pounds. This was in second gear and on ground twice disked.

Measurements to determine wear were made only on the parts of the engine most subject to wear, not on transmission of final drives. The wear on cylinder walls, pistons, wristpins, crankpins, and crankpin bearings was found to be too small to be measured by the micrometers available. The wear on the top piston rings and ring grooves was measureable but so slight that in no case was replacement necessary or desirable. In fact, these parts were just "nicely run in" and ready to begin their life work. The field was quite dusty and had the design not been such as to exclude dust from the carburetor and breather and to remove foreign matter from the crankcase oil, the final condition of the engine would undoubtedly have been less satisfactory. The air cleaner used was a "Pomona," the breather cleaner on oily fiber filter type of the tractor company's own make, the crankcase oil filter had two "Hall-Winslow Filtrator" elements in a case made by the tractor manufacturer. The piston rings were plain, mitre-cut, the weight averaging slightly less than 25 grams (0.83 oz.) The losses of weight, average, were as follows: Top ring, 0.1867 gram; second ring, 0.0631 gram; third ring, 0.0592 gram; fourth ring, 0.0487 gram, and fifth ring, 0.0468 gram. The losses of weight in per cent of original weight were, respectively, 0.0759, 0.0025, 0.0024, 0.0020, and 0.0019. As will be noted, there is a very sharp drop off in wear between the top ring and the rest. If dust had come in in any appreciable amount through the carburetor the drop off would have been less abrupt. The wear in ring groove width was more difficult to measure accurately. It was very slight, varying from nothing to 0.0008 inch, with an average of 0.00035 inch. The wear in wristpin bushings average 0.00029 inch, with a maximum of 0.0006 inch. The wear on the other parts measured was practically zero.

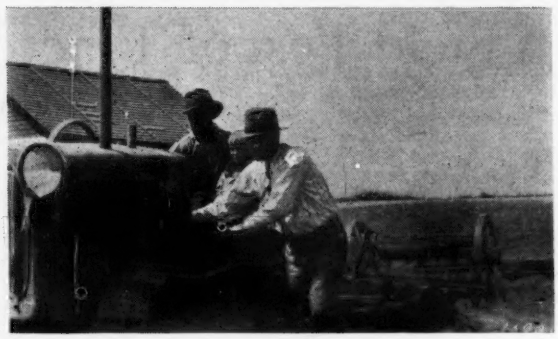


Fig. 3. Professor Harry B. Walker, head of the department of agricultural engineering, University of California, turns off the ignition switch for the official close of the test

The Scheiffle System of River Bank Protection

By Roy N. Towl[1]

A MEANS of river bank protection introduced by O. S. Scheifele of Waterloo, Ontario, Canada, involves a new system of angular or inclined tree planting.

There is an urgent need for better application of mechanical principles in the use of vegetation to bind and reinforce earth embankments, levees and river banks. Caving banks destroy individual trees in rapid succession. However, if those trees were systematically tied together, forming a living mattress, the river bank would be secure against erosion.

The Scheifele system of protection consists of planting a series of white willow poles, laid with butts at or below water level and extending up the slope to the top of the bank. These parallel poles, lightly covered with earth develop an extensive root system and send up shoots at every joint. The interwoven roots form a living mattress which will withstand high velocities when well established. The shoots cover the slope from low water to the top of the bank. If the lower shoots are removed the remaining top shoots will support the entire root system through the original planted pole. This planted pole continues to grow and furnish sap moisture from the bottom to the top of the system. Specimen poles, from one to four years old, removed from various projects for examination, were found alive and in perfect condition.

This novel method is better than mechanically binding a grove of trees, since all roots will continue to grow even if a part of the shoots are destroyed by ice or otherwise removed. Also, inclined planting will survive inundation which would destroy individual trees.

Dwarf willows, bordering mountain torrents, have protected river banks against extremely high velocities where the shoots were laid flat by the flood and matted the banks. The principal claim for willows alone is to prevent horizontal erosion. Other protection is used to combat vertical scour or under cutting. In this case steel jetties, retards, rip rap, willow mats and other systems provide the base and angular willow planting the top course from low water to high water lines.

The Scheifele system has been successfully used on projects installed by the City of Buffalo, Ontario Hydro-Electric Commission, Canadian Pacific Railway, Ontario Highway Department and various individuals. Other proven uses are: Levee protection; seepage reductions; spillway protection; slide prevention; screen to collect sediment and drift forming natural levees or training banks.

[1]Towl, Nelson and Schwartz, consulting engineers. Mem. A.S.A.E.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Electricity Consumption on the Farm, F. D. Paine (Electrical World, (New York, N. Y.) 91 (1928), No. 16, p. 821).—Records of the consumption of electricity on the rural electrification project of the Iowa Experiment Station are briefly presented, indicating that the actual use of electricity for 1 year was 1,548 kw. hours.

Sprinkling Irrigation on Vegetable Farms in New Jersey, H. F. Huber, E. R. Gross, and D. B. Lucas (New Jersey Stations (New Brunswick, N. J.) Bulletin 453 (1927), pp. 48, figs. 27).—The results of an investigation in the use of sprinkling irrigation on vegetable farms in New Jersey, conducted jointly by the departments of horticulture and agricultural engineering at the station, are presented in considerable detail, together with practical information on the organization, planning, and installation of the systems. A special part of the bulletin is devoted to the mechanical equipment required.

Residual Effects of Different Irrigation Treatments on the Crops Grown the Succeeding Year, D. W. Robertson and A. Kezer (Journal American Society of Agronomy, (Geneva, N. Y.) 19 (1927), No. 10, pp. 923-943, figs. 2).—The effects of different irrigation treatments applied to wheat on succeeding wheat crops were studied at the Colorado Experiment Station.

Irrigation late in the growing season, i.e., at heading, blossoming or filling, influenced the following crop more than where water was applied at germination or tillering or where the plats received a distributed irrigation. When the crops of the 2 years were combined the plats receiving a distributed irrigation gave the highest yield of grain and straw. Plats irrigated at heading gave the highest yield of the plats receiving a single irrigation of 6 in. Determinations at the end of the first season showed that more moisture was left in the first 5 ft. of soil when the plats were irrigated at filling, and that the quantity decreased with earlier application. Rainfall during the crop year affected the yield but not the ranking of the different treatments. The succeeding crop grown on the plats irrigated at filling gave the highest yield, whether the rainfall was 5.64 or 23.26 in.

Water Requirements of Crops, E. S. Hopkins (Canada Experiment Farms, (Ottawa, Can.) Division Field Husbandry Report 1926, pp. 34-37, fig. 1).—The averages of from 3 to 5 years' results at Swift Current, Saskatchewan, where the mean annual rainfall for the growing season, April to July, inclusive, is 8 in., showed the following number of pounds of water to be used to produce 1 lb. of dry matter: Wheat on fallow 489 lbs. for the whole plant and 1,275 lbs. for the grain; wheat after wheat 764, 2,082; wheat after corn 628, 1,587; wheat after sunflowers 825, 2,562; oats following wheat 619, 2,057; and fall rye on fallow 352, 1,005 lbs. Corn after wheat required 442 lbs. of water for 1 lb. of dry matter in the whole plant sunflowers after wheat 658, brome grass after wheat 1,024, and sweet clover after wheat 1,113 lbs.

The Use of Dynamite for Ditch Blasting, A. J. McAdams (Missouri Agricultural College (Columbia, Mo.) Extension Circular 190 (1927), pp. 20, figs. 24).—Practical information on the use of dynamite for ditch blasting is presented, together with a table of suggested loads, spacing, and depths for ditches of of various sizes under various conditions.

Relation of Depth to Curvature of Channels, H. C. Ripley (American Society of Civil Engineers (New York, N. Y.) Transactions, 90 (1927), pp. 207-265, figs. 16).—The object of this paper is to record the results of investigations into the laws of river hydraulic. As a result two empirical formulas have been devised by means of which the cross profile of a channel may be computed. Some practical applications of these formulas are given which furnish the solution to the problems which heretofore have been considered not susceptible of solution.

Irrigation Requirements of the Arid and Semiarid Lands of the Missouri and Arkansis River Basins, S. Fortier (U. S. Department of Agriculture (Washington, D. C.), Technical Bulletin 36 (1928), pp. 112, pl. 1, figs. 18).—In this report all dependable data available on water requirements of crops in the basins of the Missouri and Arkansas Rivers and adjacent territories are presented in tabular form and discussed.

Trials of Sub-Soiling in 1925 (Journal of the Ministry of Agriculture [Great Britain], 33 (1926), No. 6, pp. 513-517).—The results obtained in the third year of an experiment previously noted are briefly reported. The results show that each subsoiled plat again produced a greater yield than those in the same field which were not subsoiled. While the increase was not always as marked as in previous years, it was substantial and afforded sufficient evidence that the beneficial effect of subsoiling lasts for at least three years.

Experiments with Irrigation and Subirrigation [trans. title], C. Cerasino (Bari Station Agricultural Sper., (Bari, Italy) Publication 10 (1927), pp. 31, pls. [4].—Comparative tests of three different systems of subirrigation with surface irrigation on a number of field and vegetable crops are reported. In the majority of cases subirrigation gave the best results, cotton and tomatoes being exceptions. Subirrigation, however, presents the disadvantage of consuming greater amounts of water and of being considerably more expensive.

Irrigation Investigations at the Irrigation Substation, C. C. Wright (Washington College Station (Pullman, Wash.) Bulletin 222 (1927), pp. 69-71.)—The progress results of water measurement, irrigation, evaporation, and alkali reclamation experiments are presented briefly. In the evaporation experiment it was found that the more water the soil contained the greater was the amount lost by evaporation.

Notes on the Relative Resistance of Various Cements to the Action of Sulphate Waters, T. Thorvaldson (Engineering Journal [Montreal, Canada], 11 (1928), No. 3, pp. 180-183, figs. 2).—This is a contribution from the University of Saskatchewan in which progress data on the resistance of various cements to the action of sulfate waters are presented and discussed.

Farmers' Purchase Agreement for Deep Well Pumps, B. D. Moses and L. S. Wing, California Station (Davis, Calif.) Bulletin 448 (1928), pp. 46, figs. 3).—The purpose of this bulletin, which is a contribution from the station, the California Farm Bureau Federation, and the California Committee on the Relation of Electricity to Agriculture, is to present a new form of contract for the purchase of deep well pumps. The text of the form is given.

Harvesting Grain with the Combined Harvester-Thresher in Northwest Texas, H. P. Smith and R. F. Spilman (Texas Station (College Station, Tex.) Bulletin 373 (1927), pp. 24, figs. 7).—Studies conducted in cooperation with the U.S.D.A. Bureaus of Agricultural Economics and Public Roads are reported.

An analysis of 72 records secured from wheat growers in northwest Texas who used combines in 1926 showed that the cost of harvesting is lowered, the amount of labor required is reduced, and the period of harvesting and threshing is shortened by the use of the combine. The cost of harvesting and threshing with the combine ranged from $1.42 to $2.06 per acre and from 5 to 13 cents per bushel. The number of hours of labor per acre required for harvesting and threshing where the wheat was bound or headed and threshed with the stationary thresher was 4.6 when the binder was used, 3.8 when the header was used, and only 0.75 when the combine was used.

The most common sizes of combines used ranged from 12 to 16 ft. and were of the engine type. The number of acres harvested per day varied from 15.6 for the 8-ft. power take-off to 53 for the 20-ft. auxiliary engine type.

Big Teams on Illinois Farms, E. T. Robbins, (Illinois Station (Urbana, Ill.) Circular 324 (1928), pp. 16, figs. 13).—Practical information on the efficient use of big teams on Illinois farms is given, based on the experience of farmers.

Book Review

"Plans for Concrete Farm Buildings" is a bulletin recently issued by the Portland Cement Association, Chicago, which covers in a comprehensive manner the subject of farm building construction with concrete. In this publication an attempt has been made to assemble suggested plans for the principal farm structures, together with estimates of concrete materials required for their erection. For the farmer contemplating new construction it should prove a helpful building manual. It is also of value to the engineer for reference purposes. It contains chapters covering a farm building plan service, fundamentals of good concrete, how to figure quantities, concrete masonry construction, foundations, walls and floors, milk houses, ice houses, smoke houses, poultry houses, hog houses, grain bins and corn cribs, manure pits, garages, farm shops and machine sheds, storage cellars, water tanks, barns, residences, etc.

AGRICULTURAL ENGINEERING

Established 1920

A journal devoted to the advancement of the theory and practice of engineering as applied to agriculture and of the allied arts and sciences. Published monthly by the American Society of Agricultural Engineers, under the direction of the Publications Committee.

PUBLICATIONS COMMITTEE

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The Society is not responsible for the statements and opinions contained in the papers and discussions published in this journal. They represent the views of the individuals to whom they are credited and are not binding on the Society as a whole.

Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

Original articles, papers, discussions, and reports may be reprinted from this publication, provided proper credit is given.

RAYMOND OLNEY, Editor

Seeking the Facts About Large-Scale Farming

THIS issue of AGRICULTURAL ENGINEERING features large-scale farming, a subject much discussed and of lively interest generally at this time. The issue contains all the papers and accompanying discussions presented at the symposium, entitled "Present Status and Trend of Large-Scale Farming," to which an entire day was devoted at the meeting of the Power and Machinery Division of the American Society of Agricultural Engineers held at Chicago last month.

The Society is especially interested in large-scale farming, whether it be of the group management, corporation or family-owned and operated type. It is interested largely because of the greater possibilities offered by these larger enterprises for the application of engineering and, further, because engineering is such a vital factor in the success or failure of these projects. The small farm, as a rule, like the small factory does not present the opportunity for the engineer to exercise his function of increasing the efficiency and economy of operation, as does the large-scale enterprise.

It should be said, however, that the American Society of Agricultural Engineers is neither for nor against large-scale farming, corporation farming, or whatever name this new industrialized type of farming may be called. Those responsible for planning this part of the program of the Power and Machinery Division meeting sought to have presented both the pros and cons of this subject. In other words, their object was to bring out the facts.

The Society is decidedly for that type of farming which will prove most economically successful, which will insure to farm folks a larger opportunity for material and spiritual advancement, and which will tend to build up rather than tear down our ideal of the social order in the agricultural community that has been one of America's most cherished traditions and that we want most of all to see maintained.

One editorial writer recently made this statement: "The industry of farming has within the last few years entered into an era of transition that is absolutely nothing less than an actual revolution; as portentous in its importance as were the beginnings of the industrial revolution a little more than a century ago." The engineers have had a part in this development. The engineered methods and equipment, for which they are responsible, have been an important factor in the transition that has and is taking place. The agricultural engineer is interested in more than merely finding an opportunity to make use of his engineering talents; he is interested, first of all, in helping to make agriculture a more profitable industry for those engaged in it and to provide the means for raising the standard of farm living. The function of the American Society of Agricultural Engineers, as the national organization representing agricultural engineers, is to bring to a focus the activities of its individual members and to offer this joint effort as its contribution to the development of agriculture along lines that will be sound from the engineering, economic, and social standpoints—that will prove of greatest value to the people in agriculture.

In brief, the Society is for that which is best for farm folks and for agriculture as an industry—and that, in turn, will inevitably prove the best for all classes of our population and for all branches of industry and business. The Society does not undertake to say what type or types of farming will prove the best for agriculture. No doubt all types will survive to some extent. That type will survive which proves most economically successful under the given conditions, but there are a great variety of conditions, various combinations of which will determine the type of agriculture that will be followed in any individual case. A.S.A.E. is merely undertaking to find the facts, and not to promote any particular type of farming.

Team Work for Economists and Engineers

THE large-scale farming session sponsored by the Power and Machinery Division of the American Society of Agricultural Engineers at its recent meeting in Chicago, brought out the fact that the agricultural economists and the agricultural engineers have a great deal in common —that the trend toward large-scale farming emphasizes the necessity of close coordination of effort between these two groups.

The system of group management of farms is being rapidly adopted in the Middle West. Corporation farming is experiencing considerable development, especially in the typical grain-growing sections. And there is a decided trend toward larger family owned and operated farms, especially where good managerial ability is found and where mechanical power and modern equipment is employed extensively.

Agriculture seems due for widespread, revolutionary changes. In fact, these changes are already well advanced. Whatever type or system of farming is evolved to meet a given set of conditions, many new and trying problems will be met. That the trend seems inevitably toward larger-scale operations, regardless of whether it be of the group management, corporation, or individual family type, is becoming more and more generally recognized. This latter development complicates the agricultural problem as a whole, and while the responsibility for working it out rests finally on the farm manager himself, yet the agricultural economist and the agricultural engineer each have an important contribution to make to its solution. In fact, it is on these two groups of specialists that the agricultural industry, or industries to be correct, will depend in a large measure for developing certain technical aspects of this problem that are essential to reconstructing the industry to meet successfully the changes that are being forced upon it.

The value of the contribution of each group will be in proportion to the extent to which it understands and recognizes the particular contribution of the other group and seeks its cooperation in a combined effort to render agriculture a real service.

The opportunity for some effective team work between economists and engineers is at hand.

Who's Who in Agriculture Engineering

L. F. Livingston

F. N. G. Kranich

K. J. T. Ekblaw

H. B. Josephson

L. F. Livingston

Lawrence F. Livingston (Mem. A.S.A.E.) is manager of the newly created agricultural extension section of the E. I. du Pont de Nemours Company. Since graduating in civil engineering and forestry from the University of Washington, he has been closely identified with land clearing and extension work, with the exception of a period during the war when he saw service as first lieutenant in the 22nd Engineers. For some time before entering the army he was in charge of the land clearing work of the University of Wisconsin. Returning from overseas, he again became associated with land clearing work in Wisconsin, this time as secretary of the Marinette County Land Clearing Association. During 1921 he accepted a position in agricultural engineering extension work with Michigan State College and has more recently been in charge of agricultural engineering extension work at that institution. His new position will enable him to continue his land clearing and extension work along commercial lines. In the Society he has been chairman of the Committee on Land Clearing, the Committee on Forestry, and the Extension Committee, and has contributed to AGRICULTURAL ENGINEERING a number of articles along these lines.

F. N. G. Kranich

Frank N. G. Kranich (Mem. A.S.A.E.) is associated with the J. I. Case Threshing Machine Company in engineering, sales and research work. He is one of the pioneers in the agricultural engineering field, having become a member of the Society in 1912, at which time he already had more than thirteen years experience in agricultural engineering work. In his engineering work for various farm machinery manufacturers he has studied farm machines in the field practically all over the United States and considerable of South America. His ability and long and varied experience gives authority to his word on matters of farm machinery design, construction, and use. "Farm Equipment for Mechanical Power," written by Mr. Kranich for farmers, dealers, distributors, service men, and agricultural engineering students, was chosen by the American Library Association as one of the ten books of greatest value to the farmer's library. He is also well know for his many contributions to various farm and trade papers. He was president of the Society in 1920, a notable year in its activities. During that year the Society enjoyed an unusual growth in membership. It was also during that year the Society started publishing AGRICULTURAL ENGINEERING.

K. J. T. Ekblaw

Karl John Theodore Ekblaw (Mem. A.S.A.E.) is consulting agricultural engineer and vice-president of the Frank B. White Company. At the University of Illinois he received his bachelor's degree in mechanical engineering in 1909 and his master's degree in architecture in 1913. In 1917 he received his professional degree in mechanical engineering from Yale University for work in the Sheffield Scientific School and at the University of Illinois. During the period 1909 to 1916 he was on the staff of the department of farm mechanics of the University of Illinois. The department of agricultural engineering at Kansas State Agricultural College was organized under his direction in 1917 and he served as professor and head of the department until 1919. For about two years following that, he was agricultural engineering editor of a group of farm papers. From 1921 to 1925 he was agricultural engineer for the Portland Cement Association and from 1925 to 1927 he was consulting agricultural engineer for the Association. He is author of "Farm Structures" and "Farm Concrete," two important books in their field. His activities in the Society include a number of important committee appointments.

H. B. Josephson

H. B. Josephson (Mem. A.S.A.E.), as engineer in charge of agricultural enginering research at Pennsylvania State College since 1925, has been working on power and labor problems with special reference to lowering the cost of producing farm crops. Raised on a large grain farm in western Canada he gained a great deal of experience with power farm machinery in his early years. After three years at Manitoba Agricultural College and three more years at the University of Saskatchewan he received his bachelor's degree in agriculture from the latter institution in 1922. Immediately upon graduation he became an instructor in the agricultural engineering department at his Alma Mater. In 1924 he went to Iowa State College as graduate assistant in agricultural engineering and obtained his master's degree in agricultural engineering in 1925 for his thesis, "The Design of a General Purpose Tractor. Since that time he has held his present position. A series of six technical papers by Mr. Josephson, based on the results of his power and labor research studies, appeared in AGRICULTURAL ENGINEERING during the latter half of 1928. He is also author of other articles which appeared in earlier issues of AGRICULTURAL ENGINEERING.

A. S. A. E. and Related Activities

The Division Meetings in Chicago

IN COMPETITION for interest with the numerous other agricultural, and also engineering, events and attractions of Chicago during the week of the International Livestock Exposition, the technical division meetings of the American Society of Agricultural Engineers were highly successful. In addition to the division members, many visitors came for hundreds of miles principally to attend these meetings, while others who dropped into the sessions to hear a paper or two, forget their other business, stayed for the day, and in some cases came back for more. From the time President Wm. Boss filled out the first registration card on the morning of December 4, until the finish gun on the afternoon of December 7, interest could be measured in terms of either the number of breakfasts missed, the amount of discussion in the meetings, or the comparative absence of lobbying during the sessions. Luncheons served in the meeting room helped keep the crowd and their thoughts from straying during the noon intermissions.

"The Present Status and Trend of Large-Scale Farming" proved a live subject for the opening session on the Power and Machinery Division program. Here traditions with no foundation in reason found little support; the past of agriculture was not pointed out as an ideal to work back to; its present was considered "as is" and its future was mentally explored in a vigorous manner and without fear of encountering any man-eating monsters, bottomless pits, or stone walls. In fact, this attitude maintained throughout the meeting.

Dr. E. G. Nourse of the Institute of Economics and Prof. M. L. Wilson of the University of Montana presented the economic angles of the subject; Thomas D. Campbell, America's largest farmer, gave the benefit of his long experience in large-scale farming in the West; and D. Howard Doane, of the Doane Agricultural Service, J. N. Dowell, of the Do-Well Agricultural Service, and J. Ward Nelson, of the Midwest Canning Corporation, contributed the viewpoint of the Midwestern farm manager. Indications are that large-scale farming will demand a day on the program again at next winter's meeting.

Two other symposia, although of less popular interest, were also important. "New Developments in Combine Harvesting and Grain Drying" with reports from all frontiers of the combine's spread, the Northwest, Middle West and East, brought that subject up-to-date in agricultural engineering literature. "Requirements of the General-Purpose Tractor" will also probably necessitate another session, as it was scarcely possible in the few hours available to more than outline the points which need additional study.

Individual papers on hay drying, corn borer control, weed control and the application of power to soil pulverization were presented as scheduled.

The Rural Electric Division and the Structures Division programs were held simultaneously. At the rural electric sessions were a goodly number of visitors representing public utilities just beginning to get interested in rural electrification. The first day was given to papers on wiring and various applications, including motors, water systems, feed grinding, refrigeration, seed corn testing and ventilation. Spirited discussions followed these papers. As no one seemed to want to miss anything, the several round table conferences scheduled for the second day were held successively in the regular meeting room. The time for them was limited to the morning to enable the group to be the guest of the Public Service Company of Northern Illinois for an afternoon inspection trip to its model electrical farm.

Some excellent new material was presented before the Structures Division. H. B. White, agricultural engineer, University of Minnesota, presented a paper on "The Dairy Barn from a Manufacturing Point of View," based on recent time and movement studies of dairy barn operation. "Recent Developments in Heat-Treated Aggregates" was the title of a paper by T. H. Merriam of the Portland Cement Association.

All afternoon and the following day was given by the Division to a consideration of research and standards in the field of farm structures. Henry Giese, agricultural engineer, Iowa Agricultural Experiment Station, presented a conprehensive plan for "The Development of Research in Farm Structures." Plans were also outlined for the development of tentative standards.

Principal papers and discussions presented at all of these meetings will be made available by publication in this Journal as rapidly as space permits. This issue is devoted to the large-scale farming session. "The combine and grain drying reports are to appear in the February issue and the rural electric and structures papers are scheduled for March and April, respectively. Some of these issues will be especially large ones, for which special single copy prices will be charged. The additional rate will not effect the regular subscribers.

Moline Picked for 1930 Annual Meeting

THE Council of the American Society of Agricultural Engineers has accepted the invitation of the farm equipment industries, the local business organizations, and the city, to hold the 1930 annual meeting at Moline, Illinois.

One of the principal reasons for this decision is that the Tri-Cities, consisting of Moline, Davenport, and Rock Island, are recognized as the leading center in the world for the manufacture of farm implements and machines. It is appreciated that such a center holds unusual attractions for agricultural engineers and makes a particularly desirable place for holding an annual meeting of the Society.

1929 Annual Meeting Dates

THE Council of the American Society of Agricultural Engineers has definitely scheduled the 23rd annual meeting of the Society to be held at Dallas, Texas, for the week beginning June 16, 1929. Due to the difficulty of scheduling group meetings that it seems desirable to hold, either in advance or following the annual meeting proper, it has not yet been definitely decided whether the meeting will begin on Monday, June 17, or on Wednesday, June 19. It is anticipated that this matter will be settled at an early date.

Sjogren Granted Leave

THE board of regents of the University of Nebraska have granted Oscar W. Sjogren, professor of agricultural engineering and chairman of the department, a year's leave of absence starting February 1. The health of his youngest son requires his being in a climate less rigorous than that of Nebraska and for that reason Mr. Sjogren is going to California. He will be connected with the Killefer Manufacturing Company of Los Angeles during his leave. His work with the company will be that of agricultural engineer, and he will devote his efforts largely to research and development.

E. E. Brackett, professor of agricultural engineering, has been appointed as acting chairman of the department.

Southern and Southwest Sections to Meet at Houston

THE second joint meeting of the Southern and Southwest Sections of the American Society of Agricultural Engineers will be held at the Rice Hotel, Houston, Texas, February 5, 6 and 7, in conjunction with the annual meeting of the Association of Southern Agricultural Workers.

Sessions of the agricultural engineers are scheduled for the afternoon of the three days named, the mornings and evenings being left open for their attendance at sessions of the Association of Southern Agricultural Workers.

Speakers will practically all be members of one or the other of the Sections. In addition S. H. McCrory, chief, division of agricultural engineering, U. S. D. A., will talk on "The Future of Extension Work in Agricultural Engineering" and T. C. Richardson, field editor of "Farm and Ranch," will talk on "Opportunities for the Application oof Agricultural Engineering.

Other subjects and features scheduled are as follows:

"Utilization of Power and Power Equipment in Corn and Soybeans"—C. L. Osterberger, agricultural engineer, Louisiana State University.

"A Report on the Production of Peanuts with Power Machinery"—S. P. Lyle, professor of agricultural engineering, University of Georgia.

"Reducing Production Costs Through Utilization of Large Power Units and Improved Machinery"—F. R. Jones, agricultural engineer, A. & M. College of Texas.

"Cotton Picking Machinery"—Dan Scoates, professor of agricultural engineering, A. & M. College of Texas.

"The Organization of Rural Electric Lines"—L. W. Gray, agricultural engineer, Georgia Power Co.

"Some Recent Developments in Rural Electrification"—E. C. Easter, agricultural engineer, Alabama Power Co.

"Laboratory Studies on the Use of Toxic Chemicals to Control Wood Destroying Fungi"—Harold T. Barr, agricultural engineer, University of Arkansas.

"Southern Building Design"—L. E. Hazen, professor of agricultural engineering, Oklahoma A. & M. College. Discussion: "New Building Designs for Southern Conditions"—Deane G. Carter, professor of agricultural engineering, University of Arkansas.

"The Control of Erosion in Oklahoma"—G. E. Martin, professor of agricultural engineering, Oklahoma A. & M. College. Discussion: "Relation of Slope and Vertical Interval to the Run-off from Terraces"—R. W. Baird, agricultural engineer, Oklahoma A. & M. College.

At the close of the technical sessions on February 7 each Section will hold a separate business meeting. The Southwest Section will have business in preparation for its serving as host to the Society at its twenty-third annual meeting at Dallas in June of this year.

Texas Student Branch to Stage Second Annual Auto and Farm Implement Show

MORE than double the crowd of 4,000 visitors which attended the show last year are expected at the second annual automobile and farm implement show to be put on the by the student branch of American Society of Agricultural Engineers, at Texas A. & M. College on February 8, 1929. The show this year will be held on Kyle Field, at College Station, Texas, opening at 7:30 p.m.

A special feature of the show will be a display of mechanical cotton harvesters in which the picker, stripper, and sled types will each be represented by one or more machines.

Twenty new models of well-known makes of autos will be brought in and driven in review by girls. The development of the automobile from its early history to present day will be shown by an exhibition of models of successive periods. The latest in trucks, tractors and other heavy and light lines of farm implements will also be on display.

This show is put on primarily for the information of the farmers of the state. Members of the agricultural engineering faculty of the college will be present to answer questions on any phase of the application of engineering to agriculture.

Dairy Machinery Interests Meet on West Coast

PROGRESS in dairy machinery and its acceptance as a matter of importance to the dairy industry was made at the dairy machinery meeting held in conjunction with the Pacific Slope Dairy Show at Oakland, California, November 22. The program was sponsored by both the Committee on Dairy Equipment and the Pacific Coast Section of the American Society of Agricultural Engineers.

Cooling and refrigeration seemed to be the problem of greatest interest. The morning session of the meeting was given over to that subject. The view point of the plant manufacturer, arrangement and cost of dairy equipment, engineering in dairy production, water softeners, paints, and machine-cut steel gears and anti-friction bearings for dairy machinery were taken up in papers of the afternoon session.

A resolutions committee presented the following report which was passed by the members of the Section:

"The Pacific Coast Section of the American Society of Agricultural Engineers expresses its appreciation and thanks to the officers and members of the Pacific Slope Dairy Show Association for the splendid accommodations and hearty cooperation accorded the Section in making its meeting held in connection with the 8th Annual Pacific Slope Dairy Show a success.

"The Pacific Coast Section of A.S.A.E., realizing the importance of refrigeration in dairy production and believing greater progress will come from a better understanding of the problems of the producer of dairy products and the related industries which are designing and manufacturing equipment, recommends the appointment by the chairman of the Pacific Coast Section of a committee of these and related groups to make a study of refrigeration in the field and prepare recommendations to the Society with a view of standardizing practice in dairy product refrigeration.

"We highly commend the splendid work of the Dairy Industry, Animal Husbandry, and Agricultural Engineering Divisions of the University of California in their studies of dairy production and manufacturing equipment. We further express our appreciation of the cooperative studies of the Universtiy of California made possible through the cooperation and support of the California Committee on the Relation of Electricity to Agriculture."

Personals of A.S.A.E. Members

C. E. Ramser, senior drainage engineer, division of agricultural engineering, U.S.D.A., has been transferred from Cape Girardeau, Missouri, to Guthrie, Oklahoma. At his new location he is to conduct a number of experiments with the object of solving many of the practical problems in connection with the prevention of soil erosion. In this project the Division of Agricultural Engineering is cooperating with the Guthrie Chamber of Commerce which has leased a 150-acre farm which is all to be terraced and operated as a going farm by the Division.

Ching Po Sun was recently engaged by the Kiangsu provincial government to organize the Kiangsu Farm Implement Manufactory, Soochow, China, for making plows, cultivators, and planters of all kinds, also pumps and crude

oil engines for irrigation purposes. It is the first establishment of its kind in China.

John Swenehart, after January 1, will be in charge of agricultural explosives development, trade promotion and sales for the Atlas Powder Company, Wilmington, Delaware. He was previously professor of agricultural engineering at the University of Wisconsin.

J. E. Waggoner has recently accepted a position of manager of the newly created public relations division of the sales department of Delco-Light Company, Dayton, Ohio. He was previously research agricultural engineer of Texas A. & M. College, College Station, Texas.

J. C. Wooley is on leave of absence from his duties as professor of agricultural engineering and head of the department at the University of Missouri. During his leave he will devote his time to research work with the University of California for the purpose of securing a doctor's degree.

Frank J. Zink, assistant agricultural engineer, engineering experiment station, Iowa State College, and field engineer for the Iowa project on rural electrification, is joint author with F. D. Paine, of Report No. 4, entitled "Characteristics of Rural Distribution Lines," recently issued by the Engineering Experiment Station.

New A.S.A.E. Members

John S. Bird, president, Wheat Farming Company, Topeka, Kan.

Allan B. Campbell, electrical engineer, National Electric Light Association, New York, N. Y.

Ben. W. Faber, agricultural engineer, Westinghouse Electric & Mfg. Company, East Pittsburgh, Penna.

Roy W. Gifford, general superintendent of factories, Massey-Harris Co., Ltd., Toronto, Canada.

Charles T. Gilliam, assistant commercial manager, Central Power and Light Company, San Antonio, Tex.

Joseph H. Godfrey, director of research and publicity, The Creamery Package Mfg. Company, Chicago, Ill.

James H. McAfee, salesman, Advance-Rumely Thresher Co., New Castle, Penna.

John A. Mirtoff, director of Russian Bureau of Agricultural Information, Agricultural Academia in Moscow, U. S. S. R.

C. M. Roan, vice-president and secretary, Self Kleen Thresher Screen Company, Minneapolis, Minn.

Lawrence O. Russell, salesman, J. I. Case Threshing Machine Co., Kansas City, Mo.

Harold M. Ware, member of commission to organize Demonstration State Farm in North Cauvasus, Zerno Trust, Kuznetski Most, Moscow, U.S.S.R.

Ralph Kenneth Wilson, district distribution engineer, Illinois Power and Light Corp., Du Quoin, Ill.

Transfer of Grade

John B. McCormick, student trainee, J. I. Case Threshing Machine Co., Racine, Wis. (Student to Junior Member.)

Norman W. Wilson, graduate assistant, Ohio State University, Columbus, Ohio. (Student to Junior Member.)

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the December issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Elmer J. Baker, Jr., secretary and associate editor, Farm Implement News Co., Chicago, Ill.

Raymond H. Bamer, superintendent of live stock, New York State College of Agriculture, Ithaca, N. Y.

Edward C. Bostock, general manager, Prairie Farm of Pitcairn Brothers, Inc., Philadelphia, Penna.

Arthur C. H. Cooke, rural service engineer, Central Power and Light Co., San Antonio, Tex.

John H. Flessner, farm representative of Detroit Edison Company, Monroe, Mich.

Arthur E. Halterman, rural electric service manager, Suburban Electric Power Co., Waldorf, Md.

Theodore W. Johnson, agricultural draftsman and designer, John Deere Plow Works, Moline, Ill.

Edward A. Johnston director of engineering, International Harvester Co., Chicago, Ill.

Stanley A. Knisely, director of research, Sheet Steel Trade Extension Committee, Cleveland, Ohio.

Wheeler McMillen, associate editor, "Farm & Fireside," Crowell Publishing Co., New York, N. Y.

Ralph W. Moltke, promotional engineer, Central Illinois Light Co., Peoria, Ill.

Russell S. Wolfe, blasting contractor, Orangeburg, S. C.

J. Frank S. Ziegler, farm manager, Prairie Farm, Alicia, Mich.

Transfer of Grade

Roy Bainer, assistant professor of agricultural engineering, Kansas State Agricultural College, Manhattan, Kan. (Junior to Associate Member.)

Cyrus A. Galley, experimental designer, John Deere Wagon Works, Moline, Ill. (Student to Junior Member.)

Paul R. Hoff, extension specialist, Ohio State University, Columbus, Ohio. (Student to Junior Member.)

W. Leland Zink, designer, General Implement Co., Racine, Wis. (Associate to Full Member.)

Employment Bulletin

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue The form of notice should be such that the initial words indicate the classification. There is no charge for this service.

Men Available

AGRICULTURAL ENGINEER, graduate of Mississippi A. & M. College and North Carolina State College of Agriculture, desires position in college work, either teaching, extension, or research. Has had teaching and extension experience for a period of nine years in southern agricultural institutions and for the past two years has handled work in drainage, irrigation, water supply and plumbing, machinery, building and repair work on a large demonstration farm in the South. MA-157

AGRICULTURAL MACHINE DESIGNER, age 38, seeks larger opportunity. A graduate in mechanical engineering, with five years of machine shop practice and mechanical drafting, and ten years in experimental department of a large agricultural implement organization manufacturing a full line of tillage and harvesting tools. Experience at bench, floor, field work and drafting. Capable of handling men. MA-155

AGRICULTURAL ENGINEER desires position as manager or assistant of an agricultural enterprise where ability will be recognized. Have had experience in managing sugar estate in West Indies and have successfully handled labor. Agricultural college graduate, 37 years old and married, will go anywhere. MA-158

AGRICULTURAL ENGINEER, graduate from the Kansas State Agricultural College, desires connection in residential college work, teaching or research. Have had practical farm experience and have been an extension specialist since graduation. MA-159.